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# HBCUs/OMUs Research Conference Agenda and Abstracts

Proceedings of a conference held at Ohio Aerospace Institute  
and sponsored by NASA Glenn Research Center  
Cleveland, Ohio  
April 17-18, 2001

National Aeronautics and  
Space Administration

Glenn Research Center

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November 2001

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GRC HBCU's/OMU's RESEARCH CONFERENCE

APRIL 17-18, 2001

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10/17/01 P. 9

National Aeronautics and  
Space Administration  
**John H. Glenn Research Center**  
**Lewis Field**  
Cleveland, OH 44135-3191



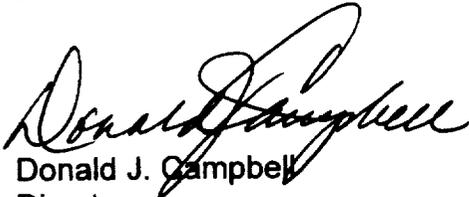
Reply to Attn of:

The NASA John H. Glenn Research Center's (GRC) commitment to excellence continues to grow in terms of investment and support for Historically Black Colleges and Universities (HBCU's)/Other Minority Universities (OMU's). Our total research and development grant awards to HBCU's/OMU's continue to exceed our performance goal by a substantial margin.

GRC's HBCU's/OMU's Research Program is designed to utilize the capabilities of HBCU's/OMU's to conduct fundamental science and develop physical infrastructure related to NASA's disciplines. To reach our goals, we build partnerships with other Government agencies, industry, and academia. Our research partnerships with the Nation's HBCU's/OMU's are an integral part of our strategy.

The HBCU's/OMU's Research Conference is a critical element in ensuring the success of GRC's research programs. In addition, it provides a forum for showcasing the research capabilities of the participating HBCU's/OMU's.

It is with great pleasure that I welcome the participants and congratulate everyone associated with the NASA HBCU's/OMU's Research Conference.

  
Donald J. Campbell  
Director



National Aeronautics and  
Space Administration

**John H. Glenn Research Center**  
**Lewis Field**  
Cleveland, OH 44135-3191



Reply to Attn of:

I extend my welcome to all attendees at this Historically Black Colleges and Universities (HBCU's)/Other Minority Universities (OMU's) Research Conference. This Conference provides the opportunity to showcase the high quality of the John H. Glenn Research Center (GRC)-sponsored research conducted at the Nation's HBCU's/OMU's. I congratulate the Principal Investigators, Student Researchers, and GRC Technical Monitors for your competence and contributions.

I invite all attendees to actively participate with your questions, comments, and suggestions concerning all aspects of the Conference. Your feedback and support are critical to the success of these Conferences.

A handwritten signature in black ink that reads "Julian M. Earls". The signature is fluid and cursive, with the first letters of the first and last names being capitalized and prominent.

**Julian M. Earls**  
Deputy Director for Operations



## HBCUs/OMUs RESEARCH CONFERENCE

April 17-18, 2001

### AGENDA

Presiding: Dr. Sunil Dutta  
SDB Program Manager

#### Tuesday, April 17, 2001

|                  |  |
|------------------|--|
| 8:00-8:30 a.m.   | Registration   |
| 8:30-9:00 a.m.   | Introduction and Welcome   |
|                  | <b>Dr. Julian M. Earls</b><br>Deputy Director for Operations<br>NASA Glenn Research Center |
|                  | <b>Mr. Donald J. Campbell</b><br>Director<br>NASA Glenn Research Center                    |
| 9:00-10:15 a.m.  | Oral Presentations   |
| 10:15-10:45 a.m. | Break  |
| 10:45-12:00 Noon | Oral Presentations   |
| 12:00-1:30 p.m.  | Lunch (On Your Own)  |
| 1:30-2:45 p.m.   | Oral Presentations   |
| 2:45-3:00 p.m.   | Break  |
| 3:00-5:00 p.m.   | Oral Presentations   |

#### Wednesday, April 18, 2001

|                      |  |
|----------------------|--|
| 8:30 a.m.-12:00 Noon | Poster Sessions  |
| 12:00-1:30 p.m.      | Lunch (On Your Own)  |
| 1:30-3:30 p.m.       | Individual Principal Investigator/Technical Monitor Meetings |
| 3:30-4:30 p.m.       | Remove Posters   |



**HBCUs/OMUs Research Conference**  
**List of Poster Papers**  
**April 17–18, 2001**

|     |                          |   |
|-----|--------------------------|---|
| P1  | Alabama A&M University   | "Low Temperature Ohmic Contact Formation of Ni <sub>2</sub> Si on N-type 4H-SiC and 6H-SiC"   |
| P2  | Alabama A&M University   | "Raman and FTIR Studies of Silicon Carbide Surface Damage from Palladium Implantation in Presence of Hydrogen"  |
| P3  | Alabama A&M University   | "Palladium Implanted Silicon Carbide for Hydrogen Sensing"  |
| P4  | Alabama A&M University   | "Optical Sensors Based on Single Arm Thin Film Waveguide Interferometer"  |
| P5  | Alabama A&M University   | "All-Optical Micro Motors Based on Moving Gratings in Photosensitive Media"   |
| P6  | City College of New York | "Remobilizing the Interface of Thermocapillary Driven Bubbles Retarded By the Adsorption of a Surfactant Impurity on the Bubble Surface"              |
| P7  | City College of New York | "Surfactant Facilitated Spreading of Aqueous Drops on Hydrophobic Surfaces"   |
| P8  | City College of New York | "Ultrasonic Assessment of Impact-Induced Damage and Microcracking in Polymer Matrix Composites"   |
| P9  | City College of New York | "Experiments With Turbulent Jets at Mach Number 0.9"  |
| P10 | Clark Atlanta University | "Substituent and Solvent Effects on Excited State Charge Transfer Behavior of Highly Fluorescent Dyes Containing Thiophenylimidazole-Based Aldehydes" |
| P11 | Clark Atlanta University | "Liquid Fuels: Pyrolytic Degradation and Fire Spread Behavior as Influenced by Buoyancy"  |
| P12 | Clark Atlanta University | "Functionalized Carbon Nanotubes"   |
| P13 | Florida A&M University   | "Robust Fault Detection Using Robust $\hat{L}_1$ Estimation and Fuzzy Logic"  |
| P14 | Hampton University       | "Advanced Methods for Aircraft Engine Thrust and Noise Benefits: Nozzle-Inlet Flow Analysis"  |
| P15 | Hampton University       | "Numerical Simulation of One- and Two-Phase Flows in Propulsion Systems"  |
| P16 | Hampton University       | "Design of Fiber Optic Sensors for Measuring Hydrodynamic Parameters"   |
| P17 | Hampton University       | "The Fabrication of an Evanescent Field Sensor"   |

|     |                                    |  |
|-----|------------------------------------|--|
| P18 | Hampton University                 | "Radiation Losses Due to Tapering of a Double-Core Optical Waveguide"  |
| P19 | Hampton University                 | "Virtual Instrumentation for a Fiber-Optics-Based Artificial Nerve"  |
| P20 | Hampton University                 | "Fiber Bragg Grating Filter High Temperature Sensors"  |
| P21 | Jackson State University           | "An Algorithm for Interactive Modeling of Space-Transportation Engine Simulations: a Constraint Satisfaction Approach"             |
| P22 | Norfolk State University           | "Novel High Efficient Organic Photovoltaic Materials"  |
| P23 | Prairie View A&M University        | "Radiation Effects on DC-DC Converters"  |
| P24 | Prairie View A&M University        | "Research to Significantly Enhance Composite Survivability at 550 °F in Oxidative Environments"                                    |
| P25 | Prairie View A&M University        | "UV Curable Polyimides"  |
| P26 | Southern University                | "Accessibility of NASA Wisdom"   |
| P27 | Tuskegee University                | "Durability and Damage Development in Woven Ceramic Matrix Composites"   |
| P28 | Tuskegee University                | "Notch Sensitivity of Woven Ceramic Matrix Composites Under Tensile Loading—An Experimental, Analytical, and Finite Element Study" |
| P29 | Tuskegee University                | "Long-Term Creep and Creep Rupture Behavior of Woven Ceramic Matrix Composites"  |
| P30 | Tuskegee University                | "Polyimide Based Nanocomposites for Affordable Space Transport"  |
| P31 | Tuskegee University                | "Study of Electrical Contacts and Devices in Advanced Semiconductors"  |
| P32 | University of Texas at El Paso     | "Kelvin Probe Measurements on Solar Cells and Other Thin Film Devices"   |
| P33 | University of Texas at El Paso     | "Annealing of Solar Cells and Other Thin Film Devices"   |
| P34 | University of Texas at San Antonio | "Reliability of a Series Pipe Network"   |
| P35 | University of Texas at San Antonio | "Reliability of a Parallel Pipe Network"   |
| P36 | Winston-Salem State University     | "Generic Divide and Conquer Internet-Based Computing"  |

**GRC HBCUs/OMUs RESEARCH CONFERENCE****Low Temperature Ohmic Contact Formation of Ni<sub>2</sub>Si on N-type 4H-SiC and 6H-SiC**

A.M. Elsamadicy, D. Ila, R. Zimmerman, C. Muntele, L. Evelyn, I. Muntele,  
D.B. Poker, D. Hensley, J.K. Hirvonen, J.D. Demaree, and M.A. George  
Alabama A&M University  
Center for Irradiation of Materials  
4900 Meridian Street, P.O. Box 1447  
Normal, Alabama 35762

**ABSTRACT**

Nickel Silicide (Ni<sub>2</sub>Si) is investigated as possible ohmic contact to heavily nitrogen-doped N-type 4H-SiC and 6H-SiC. Nickel Silicide was deposited via electron gun with various thicknesses on both Si and C faces of the SiC substrates. The Ni<sub>2</sub>Si contacts were formed at room temperature as well as at elevated temperatures (400 to 1000 K). Contact resistivities and I-V characteristics were measured at temperatures between 100 and 700 °C. To investigate the electric properties, I-V characteristics were studied and the Transmission Line Method (TLM) was used to determine the specific contact resistance for the samples at each annealing temperature. Both Rutherford Backscattering Spectroscopy (RBS) and Auger Electron Spectroscopy (AES) were used for depth profiling of the Ni<sub>2</sub>Si, Si, and C. X-ray Photoemission Spectroscopy (XPS) was used to study the chemical structure of the Ni<sub>2</sub>Si/SiC interface.

Phone: 256-851-5872  
FAX: 256-851-5868  
Tech. Monitor: David Larkin Phone: 216-433-8718

**GRC HBCU's/OMU's RESEARCH CONFERENCE****Raman and FTIR Studies of Silicon Carbide Surface Damage from Palladium Implantation  
in Presence of Hydrogen**

I. Muntele, D. Ila, C.J. Muntele, D.B. Poker, and D.K. Hensley  
Alabama A&M University  
Center for Irradiation of Materials  
4900 Meridian Street, P.O. Box 1268  
Normal, Alabama 35762

**ABSTRACT**

The ion implantation in a crystal such as silicon carbide will cause both damage in the ion track and in the substrate at the end of the ion track. We used both keV, and MeV Pd ions in fabricating electronic chemical sensors in silicon carbide, which can operate at elevated temperatures. In order to study the feasibility of fabricating an optical chemical sensor (litmus sensor), we need to understand the optical behaviour of the embedded damage in the presence of hydrogen, as well as the potential chemical interaction of silicon carbide broken lattice bonds with the hydrogen dissociated from gas by palladium. Implanted samples of silicon carbide were studied using both Raman spectroscopy and FTIR. The results of this work will be presented during the meeting.

Phone: 256-851-5872

FAX: 256-851-5868

Tech. Monitor: David Larkin Phone: 216-433-8718

**GRC HBCU's/OMU's RESEARCH CONFERENCE**

**Palladium Implanted Silicon Carbide for Hydrogen Sensing**

C.I. Muntele, D. Ila, R.L. Zimmerman, L. Muntele, D.B. Poker, and D.K. Hensley  
Alabama A&M University  
Center for Irradiation of Materials  
4900 Meridian Street, P.O. Box 1268  
Normal, Alabama 35762

**ABSTRACT**

Silicon carbide is intended for use in fabrication of high-temperature, efficient hydrogen sensors. Traditionally, when a palladium coating is applied on the exposed surface of SiC, the chemical reaction between palladium and hydrogen produces a detectable change in the surface chemical potential. We have produced both a palladium coated SiC as well as a palladium, ion implanted SiC sensor. The palladium implantation was done at 500 °C into the Si face of 6H, N-type SiC at various energies, and at various fluences. Then, we measured the hydrogen sensitivity response of each fabricated sensor by exposing them to hydrogen while monitoring the current flow across the p-n junction(s), with respect to time. The sensitivity of each sensor was measured at temperatures between 27 and 300 °C. The response of the SiC sensors produced by Pd implantation has revealed a completely different behaviour than the SiC sensors produced by Pd deposition. In the Pd-deposited SiC sensors as well as in the ones reported in the literature (1,2), the current rises in the presence of hydrogen at room temperature as well as at elevated temperatures. In the case of Pd-implanted SiC sensors, the current decreases in the presence of hydrogen whenever the temperature is rased above 100 °C. We will present the details and conclusions from the results obtained during this meeting.

Phone: 256-851-5872  
FAX: 256-851-5868  
Tech. Monitor: David Larkin Phone: 216-433-8718

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## GRC HBCU's/OMU's RESEARCH CONFERENCE

### Optical Sensors Based on Single Arm Thin Film Waveguide Interferometer

S.S. Sarkisov, D. Diggs, and M. Curley  
Alabama A&M University  
4900 Meridian Street, P.O. Box 1268  
Normal, Alabama 35762

#### ABSTRACT

Single-arm double-mode double-order optical waveguide interferometer utilizes interference between two propagating modes of different orders. Sensing effect results from the change in propagation conditions of the modes caused by the environment. The waveguide is made as an open asymmetric slab structure containing a dye-doped polymer film onto a fused quartz substrate. It is more sensitive to the change of environment than its conventional polarimetric analog using orthogonal modes (TE and TM) of the same order. The sensor still preserves the option of operating in polarimetric regime using a variety of mode combinations such as  $TE_0/TM_0$  (conventional),  $TE_0/TM_1$ ,  $TE_1/TM_0$ , or  $TE_1/TM_1$  but can also work in nonpolarimetric regime using combinations  $TE_0/TE_1$  or  $TM_0/TM_1$ . Utilization of different mode combinations simultaneously makes the device more versatile. Application of the sensor to gas sensing is based on doping polymer film with an organic indicator dye sensitive to a particular gas. Change of optical absorption spectrum of the dye caused by the gaseous pollutant results change of the reactive index of the dye-doped polymer film that can be detected by the sensor. As an indicator dyes, we utilize Bromocresol Purple doped into polymer poly(methyl) methacrylate, which shows a reversible growth of the absorption peak neat 600 nm after exposure to wet ammonia. We have built a breadboard prototype of the sensor with He-Ne laser as a light source and with a single mode fiber input and a multimode fiber output. The prototype showed sensitivity to temperature change of the order of 2 °C per one full oscillation of the signal. The sensitivity of the sensor to the presence of wet ammonia is 200 ppm per one full oscillation of the signal. The further improvements include switching to a longer wavelength laser source (750-nm semiconductor laser), substitution of poly(methyl) methacrylate with hydrophilic high-temperature polyimide, and increase the doping rate of indicator dye. All these improvements are expected to bring sensitivity to 10 ppm of ammonia per one full oscillation of signal independent on the humidity of ambient air. The proposed sensor can be used as a robust and inexpensive stand-alone instrument for continuous environment pollution monitoring.

Phone: 256-858-8106

FAX: 256-851-5622

Tech. Monitor: Grigory Adamovsky Phone: 216-433-3736

**GRC HBCU's/OMU's RESEARCH CONFERENCE****All-Optical Micro Motors Based on Moving Gratings in Photosensitive Media**

M. Curley, S.S. Sarkisov, A. Fields, C. Smith, N. Kukhtarev, M.B. Kulishov, and G. Adamovsky  
Alabama A&M University  
4900 Meridian Street, P.O. Box 1268  
Normal, Alabama 35762

**ABSTRACT**

An all-optical micromotor with a rotor driven by a traveling wave of surface deformation of a stator being in contact with the rotor is being studied. Instead of an ultrasonic wave produced by an electrically driven piezoelectric actuator as in ultrasonic motors, the wave is a result of a photo-induced surface deformation of a photosensitive material produced by an incident radiation. A thin piezoelectric polymer will deform more easily  $\text{LiNbO}_3$  or metal when irradiated with light. The type of photosensitive material studied are piezoelectric polymers with and without coatings for connecting electrodes. In order to be considered as a possible candidate for micromotors, the material should exhibit surface deformation produced by a laser beam of the order of 10 microns. This is compared to the deformations produced by static holographic gratings studied in photorefractive crystals of  $\text{LiNbO}_3$  using high vertical resolution surface profilometer Dektak 3 and surface interferometer WYKO. An experimental setup showing the oscillations has been developed. The setup uses a chopped beam from an Argon ion laser to produce the deformation while a probe beam is reflected by the thin film into a fiber which is then detected on an oscilloscope. A ramp voltage signal generator will drive the piezoelectric film in another experiment to determine the resonance of the film. A current is generated when light is incident upon the film and this current can be measured. The reverse process has already been demonstrated in other piezoelectric actuators. Changing voltage, polarity, and frequency of the signal can easily generate vibrations similar to those when light is incident on the film. This can be compared to the effects of laser interaction with light absorbing fluids such as solutions of 2,9,16,23-Tetrakis(phenylthio)-29H, 31H-phthalocyanine in chlorobenzene in capillary tubes. The possibility of using a liquid with the piezoelectric film would be a novel idea for a micromotor since the interaction of a single low power focused laser beam at 633 nm with such fluid produced an intensive circular motion.

Phone: 256-858-8236

FAX: 256-851-8560

Tech. Monitor: Grigory Adamovsky Phone: 216-433-3736

## GRC HBCU's/OMU's RESEARCH CONFERENCE

### Remobilizing the Interface of Thermocapillary Driven Bubbles Retarded By the Adsorption of a Surfactant Impurity on the Bubble Surface

Ravi Palaparthi and Charles Maldarelli  
City College of New York  
Convent Avenue and 140th Street  
New York, New York 10031

Dimitri Papageorgiou  
New Jersey Institute of Technology  
Newark, NJ 07102

#### ABSTRACT

Thermocapillary migration is a method for moving bubbles in space in the absence of buoyancy. A temperature gradient is the continuous phase in which a bubble is situated, and the applied gradient impressed on the bubble surface causes one pole of the drop to be cooler than the opposite pole. As the surface tension is a decreasing function of temperature, the cooler pole pulls at the warmer pole, creating a flow that propels the bubble in the direction of the warmer fluid. A major impediment to the practical use of thermocapillary to direct the movement of bubbles in space is the fact that surfactant impurities, which are unavoidably present in the continuous phase, can significantly reduce the migration velocity. A surfactant impurity adsorbed onto the bubble interface is swept to the trailing end of the bubble. When bulk concentrations are low (which is the case with an impurity), diffusion of surfactant to the front end is slow relative to convection, and surfactant collects at the back end of the bubble. Collection at the back lowers the surface tension relative to the front end setting up a reverse tension gradient. (This can also be the case if kinetic desorption of surfactant at the back end of the bubble is much slower than convection.) For buoyancy driven bubble motions in the absence of a thermocapillarity, the tension gradient opposes the surface flow, and reduces the surface and terminal velocities (the interface becomes more solid-like and bubbles translate as solid particles). When thermocapillary forces are present, the reverse tension gradient set up by the surfactant accumulation reduces the temperature-induced tension gradient, and can decrease to near zero the bubble's thermocapillary velocity. The objective of our research is to develop a method for enhancing the thermocapillary migration of bubbles which have been retarded by the adsorption onto the bubble surface of a surfactant impurity. Our remobilization theory proposes to use surfactant molecules which kinetically rapidly exchange between the bulk and the surface and are at high bulk concentrations. Because the remobilizing surfactant is present at much higher concentrations than the impurity, it adsorbs to the bubble surface much faster than the impurity when the bubble is formed, and thereby prevents the impurity from adsorbing onto the surface. In addition, the rapid kinetic exchange and high bulk concentration maintain a saturated surface with uniform surface concentrations. This prevents retarding surface tension gradients and keeps the thermocapillary velocity high. In our reports over the first 2 years, we presented numerical simulations of the bubble motion and surfactant transport which verified theoretically the concept of remobilization, and the development of an apparatus to track and measure the velocity of rising bubbles in a glycerol/water surfactant solution. This year, we detail experimental observations of remobilization. Two polyethylene oxide surfactants were studied,  $C_{12}E_8$  ( $CH_3(CH_2)_{11}(OCH_2CH_2)_6OH$ ) and  $C_{10}E_8$  ( $CH_3(CH_2)_4(OCH_2CH_2)_8OH$ ). Measurements of the kinetic exchange for these surfactants show that the one with the longer hydrophobe chain  $C_{12}E_8$  has a lower rate of kinetic exchange. In addition, this surfactant is much less soluble in the glycerol/water mixture because of the shorter ethoxylate chain. As a result, we found that  $C_{12}E_8$  had only a very limited ability to remobilize rising bubbles because of the limited kinetic exchange and reduced solubility. However,  $C_{10}E_8$ , with its higher solubility and more rapid exchange was found to dramatically remobilize rising bubbles. We also compared our theoretical calculations to the experimental measurements of velocity for both the non-remobilizing and remobilizing surfactants and found excellent agreement. We further observed that for  $C_{10}E_8$  at high concentrations, which exceeded the critical micelle concentrations, additional remobilization was measured. In this case the rapid exchange of monomer between micelle and surfactant provides an additional mechanism for maintaining a uniform surface concentrations.

Phone: 212-650-8160

FAX: 212-650-6835

Tech. Monitor: Bhim Singh Phone: 216-433-5396

**GRC HBCU's/OMU's RESEARCH CONFERENCE****Surfactant Facilitated Spreading of Aqueous Drops on Hydrophobic Surfaces**

Nitin Kumar, Alex Couzis, and Charles Maldareili  
City College of New York  
Department of Chemical Engineering  
Convent Avenue and 140th Street  
New York, New York 10031

**ABSTRACT**

Microgravity technologies often require aqueous phases to spread over nonwetting hydrophobic solid surfaces. Surfactants facilitate the wetting of water on hydrophobic surfaces by adsorbing on the water/air and hydrophobic solid/water interfaces and lowering the surface tensions of these interfaces. The tension reductions decrease the contact angle, which increases the equilibrium wetted area. Hydrocarbon surfactants (i.e., amphiphiles with a hydrophobic moiety consisting of an extended chain of (aliphatic) methylene  $-CH_2-$  groups attached to a large polar group to give aqueous solubility) are capable of reducing the contact angles on surfaces which are not very hydrophobic, but do not reduce significantly the contact angles of the very hydrophobic surfaces such as parafilm, polyethylene or self assembled monolayers. Trisiloxane surfactants (amphiphiles with a hydrophobe consisting of methyl groups linked to a trisiloxane backbone in the form of a disk  $((CH_3)_3-Si-O-Si-O-Si(CH_3)_3)$ ) and an extended ethoxylate  $-(OCH_2CH_2)_n-$  polar group in the form of a chain with four or eight units) can significantly reduce the contact angle of water on a very hydrophobic surface and cause rapid and complete (or nearly complete) spreading (termed superspreading). The overall goal of the research described in this proposal is to establish and verify a theory for how trisiloxanes cause superspreading, and then use this knowledge as a guide to developing more general hydrocarbon based surfactant systems which superspread. We propose that the trisiloxane surfactants superspread because their structure allows them to strongly lower the high hydrophobic solid/aqueous tension when they adsorb to the solid surface. When the siloxane adsorbs, the hydrophobic disk parts of the molecule adsorb onto the surface removing the surface water. Since the cross-sectional area of the disk is larger than that of the extended ethoxylate chain, the disks can form a space-filling mat on the surface which removes a significant amount of the surface water. In this presentation, we report the results of measurements of the molecular packing and rates of kinetic exchange of the trisiloxane surfactants at the air/water interface in order to confirm our picture of trisiloxane packing, and provide additional insight into the superspreading process. We used the pendant bubble technique as a Langmuir trough to measure the trisiloxane equation of state which relates the tension to the surface concentration. From these measurements we obtain accurate values for the maximum packing density. We find that trisiloxanes with 4 and 8 ethoxylate groups have the same maximum packing concentration, indicating that the maximum packing is controlled by the cross section of the head group. For trisiloxanes with larger than eight ethoxylates, the maximum packing increases with ethoxylate number, indicating that the disposition of the ethoxylate chain (i.e., its effective size) is controlling. This supports our picture of superspreading: The superspreading ability of trisiloxanes decreases considerably for trisiloxanes with larger than eight ethoxylates; the packing measurements indicate that for the higher ethoxylate number trisiloxanes, the compact nonpolar head groups are pushed apart by the ethoxylate chain. They leave spaces of surface water on adsorption and do not lower the solid tension as much as their lower chain analogues. Finally the report measurements of the dynamic tension reduction accompanying the adsorption of trisiloxanes onto an initially clean interface using the pendant bubble technique, and we obtain from these relaxations, the equation of state and a mass transfer model, the rate constants for kinetic exchange. We find that the rate constants for desorption of trisiloxanes are generally much slower than for analogous aliphatic polyethoxylate surfactants with identical ethoxylate chain lengths. When an aqueous drop of a superspreader solution is placed on a hydrophobic surface and begins to spread, the lower desorption rates allows the tension at the drop center to remain reduced relative to the tension of the expanding periphery, thus strengthening Marangoni forces which can assist the spreading. Marangoni forces can be especially significant in the case of superspreaders because their maximum equilibrium reduction in tension is several dynes/cm lower than for aliphatic surfactants.

Phone: 212-650-8160  
FAX: 212-650-6835  
Tech. Monitor: Bhim Singh Phone: 216-433-5396

**GRC HBCU's/OMU's RESEARCH CONFERENCE****Ultrasonic Assessment of Impact-Induced Damage and Microcracking in  
Polymer Matrix Composites**

Benjamin Liaw, Esther Villars, and Frantz Delmont  
City College of New York  
Department of Mechanical Engineering  
Materials Processing and Solid Mechanics Laboratory  
Convent Avenue and 140th Street  
New York, New York 10031

**ABSTRACT**

The main objective of this NASA FAR project is to conduct ultrasonic assessment of impact-induced damage and microcracking in polymer matrix composites at various temperatures. It is believed that the proposed study of impact damage assessment on polymer matrix composites will benefit several NASA missions and current interests, such as ballistic impact testing of composite fan containment and high strain rate deformation modeling of polymer matrix composites. Impact-induced damage mechanisms in GLARE and ARALL fiber-metal laminates subject to instrumented drop-weight impacts at various temperatures were studied. GLARE and ARALL are hybrid composites made of alternating layers of aluminum and glass- (for GLARE) and aramid- (for ARALL) fiber-reinforced epoxy. Damage in pure aluminum panels impacted by foreign objects was mainly characterized by large plastic deformation surrounding a deep penetration dent. On the other hand, plastic deformation in fiber-metal laminates was often not as severe although the penetration dent was still produced. The more stiff fiber-reinforced epoxy layers provided better bending rigidity; thus, enhancing impact damage tolerance. Severe cracking, however, occurred due to the use of these more brittle fiber-reinforced epoxy layers. Fracture patterns, e.g., crack length and delamination size, were greatly affected by the lay-up configuration rather than by the number of layers, which implies that thickness effect was not significant for the panels tested in this study. Immersion ultrasound techniques were then used to assess damages generated by instrumented drop-weight impacts onto these fiber-metal laminate panels as well as 6061-T6 aluminum/cast acrylic sandwich plates adhered by epoxy. Depending on several parameters, such as impact velocity, mass, temperature, laminate configuration, sandwich construction, etc., various types of impact damage were observed, including plastic deformation, radiating cracks emanating from the impact site, ring cracks surrounding the impact site, partial and full delamination, and combinations of these damages.

Phone: 212-650-8020

FAX: 212-650-8090

Tech Monitor: Kenneth J. Bowles Phone: 216-433-3197

59/c.p./14/34/105 JULY

P9

## **GRC HBCU's/OMU's RESEARCH CONFERENCE**

### **Experiments With Turbulent Jets at Mach Number 0.9**

Juan Agui and Yiannis Andreopoulos  
City College of New York  
Department of Mechanical Engineering  
Convent Avenue and 140th  
New York, New York 10031

#### **ABSTRACT**

A systematic investigation of the structure of turbulent jets before their interaction with shock or expansion waves was undertaken during the last year. In particular compressibility and density effects in circular jets issuing in still air were investigated experimentally. Jets with nitrogen, helium, and krypton gases at 0.3, 0.6, and 0.9 Mach numbers were investigated in detail. Particle Image Velocimetry technique was developed, tested, and used to obtain qualitative information of the two-dimensional velocity field on a plane inside the flow field, which was illuminated by a laser sheet. The motion of particles was recorded by a CCD camera, which was appropriately triggered to capture two images within a fraction of a microsecond. Statistical averaging of the data at each location reduced the large amount of acquired data. It was found that the spreading rate of the jets was reduced with increased Mach numbers or increased density ratio. It was also found that decay rates of centerline Mach numbers are higher in gases with reduced density ratio. Mach number fluctuations appear to decrease with increasing Mach number of the flow. It has been proposed that the reason for this behavior is the reduction of vortex stretching activities with increased Mach number.

Phone: 212-650-5206  
FAX: 212-650-8013  
Tech. Monitor: David O. Davis Phone: 216-433-8116

**GRC HBCU's/OMU's RESEARCH CONFERENCE****Substituent and Solvent Effects on Excited State Charge Transfer Behavior of Highly Fluorescent Dyes Containing Thiophenylimidazole-Based Aldehydes**

Javier Santos, Xiu R. Bu, and Eric A. Mintz  
Clark Atlanta University  
Center for High Performance Polymers and Composites  
223 James P. Brawley Drive, SW.  
Atlanta, Georgia 30314

**ABSTRACT**

The excited state charge transfer for a series of highly fluorescent dyes containing thiophenylimidazole moiety was investigated. These systems follow the *Twisted Intramolecular Charge Transfer* (TICT) model. Dual fluorescence was observed for each substituted dye. X-ray structures analysis reveals a twisted ground state geometry for the donor substituted aryl on the 4 and 5 position at the imidazole ring. The excited state charge transfer was modeled by a linear solvation energy relationship using Taft's  $\pi^*$  and Dimroth's  $E_T(30)$  as solvent parameters. There is linear relation between the energy of the fluorescence transition and solvent polarity. The degree of stabilization of the excited state charge transfer was found to be consistent with the intramolecular molecular charge transfer. Excited dipole moment was studied by utilizing the solvatochromic shift method.

Phone: 404-880-6886

FAX: 404-880-6890

Tech. Monitor: Javier Santos Phone: 216-433-2401

**GRC HBCU's/OMU's RESEARCH CONFERENCE****Liquid Fuels: Pyrolytic Degradation and Fire Spread Behavior as Influenced by Buoyancy**

Yaw D. Yeboah, Courtney Malbrue, Melane Savage, and Bo Liao  
Clark Atlanta University  
223 James P. Brawley Drive, SW.  
Atlanta, Georgia 30314

**ABSTRACT**

This work is being conducted by the Combustion and Emission Control Lab in the Engineering Department at Clark Atlanta University under NASA Grant No. NCC3-707. The work aims at providing data to supplement the ongoing NASA research activities on fire spread across liquid pools by providing flow visualization and velocity measurements especially in the gas phase and gas-liquid interface. The fabrication, installation, and testing were completed during this reporting period. The system shakedown and detailed quantitative measurements with High Speed Video and Particle Image Velocimetry (PIV) systems using butanol as fuel were performed. New and interesting results, not previously reported in the literature, were obtained from the experiments using a modified NASA tray and butanol as fuel. Three distinct flame spread regimes, as previously reported, were observed. These were the pseudo-uniform regime below 20 °C, the pulsating regime between 22 and 30 °C and the uniform regime above about 31 °C. In the pulsating regime the jump velocity appeared to be independent of the pool temperature. However, the retreat velocity between jumps appeared to depend on the initial pool temperature. The flame retreated before surging forwards with increasing brightness. Previous literature reported this phenomenon only under microgravity conditions. However, we observed such behavior in our normal gravity experiments. Mini-pulsations behind the flame front were also observed. Two or three of these pulsations were observed within a single flame front pulsating time period. The velocity vector maps of the gas and liquid phases ahead, during, and behind the flame front were characterized. At least one recirculation cell was observed right below the flame front. The size of the liquid phase vortex (recirculation cell) below the flame front appeared to decrease with increasing initial pool temperature. The experiments also showed how multiple vortices developed in the liquid phase. A large recirculation cell, which generally spins counterclockwise as the flame spread from right to left, was observed ahead of and near the flame front in the gas phase. Detailed quantitative measurements will be undertaken with the LDV and PIV systems using the modified NASA tray and propanol.

Phone: 404-880-6619

FAX: 404-880-6615

Tech. Monitor: Howard D. Ross Phone: 216-433-2562

## GRC HBCU's/OMU's RESEARCH CONFERENCE

### Functionalized Carbon Nanotubes

Marisabel Lebron and Eric Mintz  
Clark Atlanta University  
Center for High Performance Polymers and Composites  
223 James P. Brawley Drive, SW.  
Atlanta, Georgia 30314

Michael A. Meador, David R. Hull  
NASA Glenn Research Center  
Materials Division  
21000 Brookpark Road  
Cleveland, Ohio 44135

Daniel A. Scheiman  
Dynacs Corporation  
2001 Aerospace Parkway  
Brook Park, Ohio 44142

Peter Willis and Richard E. Smalley  
Rice University  
Department of Chemistry  
6100 Main Street  
Houston, Texas 77005

### ABSTRACT

Carbon nanotubes have created a great deal of excitement in the Materials Science community because of their outstanding mechanical, electrical, and thermal properties. Use of carbon nanotubes as reinforcements for polymers could lead to a new class of composite materials with properties, durability, and performance far exceeding that of conventional fiber reinforced composites. Organized arrays of carbon nanotubes, e.g., nanotube monolayers, could find applications as thermal management materials, light emitting devices, and sensor arrays. Carbon nanotubes could also be used as templates upon which nanotubes from other materials could be constructed. Successful use of carbon nanotubes in any of these potential applications requires the ability to control the interactions of nanotubes with each other and with other materials, e.g., a polymer matrix. One approach to achieving this control is to attach certain chemical groups to the ends and/or side-walls of the nanotubes. The nature of these chemical groups can be varied to achieve the desired result, such as better adhesion between the nanotubes and a polymer. Under a joint program between NASA Glenn, Clark Atlanta University, and Rice University, researchers are working on developing a chemistry "tool-kit" that will enable the functionalization of carbon nanotubes with a variety of chemical groups. Recent results of this effort will be discussed.

Phone: 404-880-6886

FAX: 404-880-6890

Tech. Monitor: Michael A. Meador Phone: 216-433-9518

**GRC HBCU's/OMU's RESEARCH CONFERENCE**

**Robust Fault Detection Using Robust  $L_1$  Estimation and Fuzzy Logic**

Tramone Curry, Emmanuel G. Collins, Jr., Majura Selekwa  
Florida A&M University  
FAMU-FSU Department of Mechanical Engineering  
2525 Pottsdamer Street  
Tallahassee, Florida 32310

**ABSTRACT**

This research considers the application of robust  $L_1$  estimation in conjunction with fuzzy logic to robust fault detection for an aircraft flight control system. It begins with the development of robust  $L_1$  estimators based on multiplier theory and then develops a fixed threshold approach to fault detection (FD). It then considers the use of fuzzy logic for robust residual evaluation and FD. Due to modeling errors and unmeasurable disturbances, it is difficult to distinguish between the effects of an actual fault and those caused by uncertainty and disturbance. Hence, it is the aim of a robust FD system to be sensitive to faults while remaining insensitive to uncertainty and disturbances. While fixed thresholds only allow a decision on whether a fault has or has not occurred, it is more valuable to have the residual evaluation lead to a conclusion related to the degree of, or probability of, a fault. Fuzzy logic is a viable means of determining the degree of a fault and allows the introduction of human observations that may not be incorporated in the rigorous threshold theory. Hence, fuzzy logic can provide a more reliable and informative fault detection process. Using an aircraft flight control system, the results of FD using robust  $L_1$  estimation with a fixed threshold are demonstrated. FD that combines robust  $L_1$  estimation and fuzzy logic is also demonstrated. It is seen that combining the robust estimator with fuzzy logic proves to be advantageous in increasing the sensitivity to smaller faults while remaining insensitive to uncertainty and disturbances.

Phone: 850-410-6373  
FAX: 850-410-6337  
Tech. Monitor: Ten-Huei Guo Phone: 216-433-3734

## GRC HBCU's/OMU's RESEARCH CONFERENCE

### Advanced Methods for Aircraft Engine Thrust and Noise Benefits: Nozzle-Inlet Flow Analysis

Mikhail Gilinsky, Morris H. Morgan, Alex Povitsky  
Natalia Schkolnikov, Norman Njoroge, and Calvin Coston  
Hampton University  
Hampton, Virginia 23668

Isaiah M. Blankson  
NASA Glenn Research Center  
21000 Brookpark Road  
Cleveland, Ohio 44135

### ABSTRACT

The Fluid Mechanics and Acoustics Laboratory at Hampton University (HU/FM&AL) jointly with the NASA Glenn Research Center has conducted four connected subprojects under the reporting project. Basically, the HU/FM&AL Team has been involved in joint research with the purpose of theoretical explanation of experimental facts and creation of accurate numerical simulation techniques and prediction theory for solution of current problems in propulsion systems of interest to the NAVY and NASA agencies. This work is also supported by joint research between the NASA GRC and the Institute of Mechanics at Moscow State University (IM/MSU) in Russia under a CRDF grant. The research is focused on a wide regime of problems in the propulsion field as well as in experimental testing and theoretical and numerical simulation analyses for advanced aircraft and rocket engines. The FM&AL Team uses analytical methods, numerical simulations and possible experimental tests at the Hampton University campus. The fundamental idea uniting these subprojects is to use nontraditional 3D corrugated and composite nozzle and inlet designs and additional methods for exhaust jet noise reduction without essential thrust loss and even with thrust augmentation. These subprojects are (A) Aeroperformance and acoustics of Bluebell-shaped and Telescope-shaped designs. (B) An analysis of sharp-edged nozzle exit designs for effective fuel injection into the flow stream in air-breathing engines: triangular-round, diamond-round and other nozzles. (C) Measurement technique improvement for the HU Low Speed Wind Tunnel; a new course in the field of aerodynamics, teaching and training of HU students; experimental tests of Möbius-shaped screws: research and training. (D) Supersonic inlet shape optimization. The main outcomes during this reporting period are (1) Publications: The AIAA Paper #00-3170 was presented at the 36th AIAA/ASME/SAE/ASEE Joint Propulsion Conference, 17-19 June, 2000, Huntsville, AL. The AIAA Paper #01-1893 has been accepted for the AIAA/NAL-NASDA-ISAS 10th International Space Planes and Hypersonic Systems and Technologies Conference, 24-27 April 2001, Kyoto, Japan. The AIAA Paper #01-3204 has been accepted for presentation at the 37th AIAA/ASME/SAE/ASEE Joint Propulsion Conference, being held on 08-11 July, in Salt Lake City, UT. (2) A U.S. patent #6,082,635 was granted on July 4, 2000. (3) Grants and proposals: The HU/FM&AL was awarded the NASA grant NAG-3-2495 in October 2000 and the laboratory is a primary U.S. research team in a joint project under the CRDF award granted to the NASA GRC and IM/MSU (Russia) in July 2000. (4) Theory and numerical simulations: Analytical theory, numerical simulation, comparison of theoretical with experimental results, and modification of theoretical approaches, models, grids, etc., have been conducted for several complicated 2D and 3D nozzle and inlet designs using NASA, ICASE, and IM/MSU codes based on full Euler and Navier-Stokes solvers: CFL3D, FLUENT, and GODUNOV, and others (5) Experimental Tests: (a) A new course: "Advanced Aerodynamics and Aircraft Performance" presented in spring semester, 2001; training and experimental test research using the HU LSWT. (b) Small-scale Möbius-shaped screws were tested in different conditions and their application has shown essential benefits by comparison with traditional designs. (6) Installation in the FM&AL computer system: second software TECPLOT 8.0 for the UNIX SGI workstation and free TECPLOT 7.5 for the PC Dell computer, and 2D and 3D GRIDGEN (version 9) for the UNIX SGI as well as installation of two free NASA codes, 3D MAG and VULCAN. (7) Student Research Activity: Involvement of two undergraduate students as research assistants in the current research project.

Phone: 757-727-5741

FAX: 757-727-5189

Tech. Monitor: Isaiah M. Blankson Phone: 216-433-5823

**GRC HBCU's/OMU's RESEARCH CONFERENCE****Numerical Simulation of One- and Two-Phase Flows in Propulsion Systems**

Mikhail Gilinsky, Kaushal Patel, Casey Alexander, Tyesha Thompson  
Hampton University  
Hampton, Virginia 23668

Isaiah M. Blankson  
NASA Glenn Research Center  
21000 Brookpark Road  
Cleveland, Ohio 44135

Alexander I. Shvets, Valery G. Gromov, Vladimir I. Sakharov  
Institute of Mechanics of Moscow State University  
Michurinskiy prospect, 1  
Moscow 117192, Russia

**ABSTRACT**

In this report, we present some results of problems investigated during joint research between the Hampton University Fluid Mechanics and Acoustics Laboratory (HU/FM&AL), NASA GRC, and the LaRC Hyper-X Program. This work is supported by joint research between the NASA GRC and the Institute of Mechanics at Moscow State University (IM/MSU) in Russia under a CRDF grant. The main areas of current scientific interest of the HU/FM&AL include an investigation of the proposed and patented advanced methods for aircraft engine thrust and noise benefits. These methods are based on nontraditional 3D corrugated and composite nozzle, inlet, propeller and screw designs such as a Bluebell and Telescope nozzle, Möbius-shaped screw, etc. This is the main subject of our other projects, of which one is presented at the current conference. Here we analyze additional methods for exhaust jet noise reduction without essential thrust loss and even with thrust augmentation. Such additional approaches are (a) to add some solid, fluid, or gas mass at discrete locations to the main supersonic gas stream to minimize the negative influence of strong shock waves formed in propulsion systems. This mass addition may be accompanied by heat addition to the main stream as a result of the fuel combustion or by cooling of this stream as a result of the liquid mass evaporation and boiling. (b) Use of porous or permeable nozzles and additional shells at the nozzle exit for preliminary cooling of the hot jet exhaust and pressure compensation for off-design conditions (so-called continuous ejector with small mass flow rate). And (c) to propose and analyze new effective methods fuel injection into the flow stream in air-breathing engines. The research is focused on a wide regime of problems in the propulsion field as well as in experimental testing and theoretical and numerical simulation analyses for advanced aircraft and rocket engines. The FM&AL Team uses analytical methods, numerical simulations, and experimental tests at the Hampton University campus, NASA, and IM/MSU. The main outcomes during this reporting period are (1) Publications: The AIAA Paper #01-1893 has been accepted for the AIAA/NAL-NASDA-ISAS 10th International Space Planes and Hypersonic Systems and Technologies Conference, 24-27 April 2001, Kyoto, Japan. The AIAA Paper #01-3204 has been accepted for presentation at the 37th AIAA/ASME/SAE/ASEE Joint Propulsion Conference being held on 08-11 July, in Salt Lake City, UT. (2) Grants and proposals: The HU/FM&AL was awarded the NASA grant NAG3-2495 in October 2000 and the CRDF award was granted to the NASA GRC-HU FM&AL and IM/MSU (Russia) in July 2000. A solicited proposal was submitted for the NASA NRA-01GRC-02 competition and two unsolicited proposals to NASA are in preparation. (4) Theory and numerical simulations: Analytical theory, numerical simulation, comparison of theoretical with experimental results, and modification of theoretical approaches, models, grids, etc. Such investigations have been conducted for three main problems: (a) Combustion efficiency optimization in the half-duct combustor system, (b) Drag reduction effects for blunt bodies with solid needles, and (c) Solid particle injection from the butt-end against a supersonic flow. The NASA CFL3D, HU/FM&AL, and IM/MSU GODUNOV codes were used and modified for solution of these problems. The codes are based on full Euler and Navier-Stokes solvers with and without nonequilibrium oxygen-nitrogen and air-hydrogen chemical reactions in laminar and turbulent gas flow regimes. (5) Experimental tests: In the IM/MSU supersonic wind tunnel, experimental tests were conducted with different number, location, and geometric parameters of solid needles mounted at the front of the butt-end in supersonic flow. Optimal parameters were determined that provide minimal butt-end drag in the stationary flow regime. Experimental and numerical simulation results are in good agreement. (6) Student Research Activity: Involvement of one graduate and two undergraduate students as research assistants in the current project.

Phone: 757-727-5741

FAX: 757-727-5189

Tech. Monitor: Isaiah M. Blankson Phone: 216-433-5823

**GRC HBCU's/OMU's RESEARCH CONFERENCE****Design of Fiber Optic Sensors for Measuring Hydrodynamic Parameters**

Donald R. Lyons and Carramah Quiett  
Hampton University  
Department of Physics  
Hampton, Virginia 23668

**ABSTRACT**

The science of optical hydrodynamics involves relating the optical properties to the fluid dynamic properties of a hydrodynamic system. Fiber-optic sensors are being designed for measuring the hydrodynamic parameters of various systems. As a flowing fluid makes an encounter with a flat surface, it forms a boundary layer near this surface. The region between the boundary layer and the flat plate contains information about parameters such as viscosity, compressibility, pressure, density, and velocity. An analytical model has been developed for examining the hydrodynamic parameters near the surface of a fiber-optic sensor. An analysis of the conservation of momentum, the continuity equation and the Navier-Stokes equation for compressible flow were used to develop expressions for the velocity  $\bar{v}$  and the density as a function of the distance along the flow and above the surface. When examining the flow near the surface, these expressions are used to estimate the sensitivity required to perform direct optical measurements and to derive the shear force for indirect optical measurements. The derivation of this result permits the incorporation of better design parameters for other fiber-based sensors. Future work includes analyzing the optical parametric designs of fiber-optic sensors, modeling sensors to utilize the parameters for hydrodynamics and applying different mixtures of hydrodynamic flow. Finally, the fabrication of fiber-optic sensors for hydrodynamic flow applications of the type described in this presentation could enhance aerospace, submarine, and medical technology.

Phone: 757-727-5923 or 5712

FAX: 757-727-5955

Tech. Monitor: DeVon Griffin

Phone: 216-433-8109

**GRC HBCU's/OMU's RESEARCH CONFERENCE**

**The Fabrication of an Evanescent Field Sensor**

Donald R. Lyons and Erica J. Thompson  
Hampton University  
Department of Physics  
Hampton, Virginia 23668

**ABSTRACT**

We present current results concerning novel sensor-based applications for tilted angle fiber Bragg gratings summarized in a recently filed patent. In addition, concepts involving the coupling of light out of the core region of an optical fiber using ablated corrugations to induce interactions with the surrounding media will also be discussed. The interactions between the media and the coupled light formulate the sensing mechanism for both of these devices. The research illustrated here is an extension of previous work that investigated the affects of intense UV radiation fields on both  $\text{SiO}_2$  and Ge-doped  $\text{SiO}_2$ -based structures (specifically optical fibers and preforms). Finally, these sensors were devised in order to satisfy an experimental task set forth by NASA Glenn involving the production of a prototype evanescent field sensor capable of real-time, dynamic index of refraction measurements as well as early (ultra-high sensitivity) detection of icing on airplane wings.

Phone: 757-727-5923 or 5925

FAX: 757-727-5955

Tech. Monitors: DeVon Griffin and Eric Pencil Phone: 216-433-8109 and 216-977-7463

**GRC HBCU's/OMU's RESEARCH CONFERENCE**

**Radiation Losses Due to Tapering of a Double-Core Optical Waveguide**

Donald R. Lyons and Myat Khet  
 Hampton University  
 Department of Physics  
 Hampton, Virginia 23668

**ABSTRACT**

The theoretical model we designed parameterizes the power losses as a function of the profile shape for a tapered, single mode, optical dielectric coupler. The focus of this project is to produce a working model that determines the power losses experienced by the fibers when light crosses a taper region. This phenomenon can be examined using coupled mode theory. The optical directional coupler consists of a parallel, dual-channel, waveguide with minimal spacing between the channels to permit energy exchange. Thus, power transfer is essentially a function of the taper profile. To find the fields in the fibers, the approach used was that of solving the Helmholtz equation in cylindrical coordinates involving Bessel and modified Bessel functions depending on the location. For modes inside the core the fields are

$$B_z = 0, B_\rho = -\frac{i\mu_1 \epsilon_1 \omega}{c\gamma^2} m J_m(\gamma_m \rho) e^{im\phi}, B_\phi = \frac{i\mu_1 \epsilon_1 \omega}{2c\gamma} \{J_{m-1}(\gamma_m \rho) - J_{m+1}(\gamma_m \rho)\} e^{im\phi},$$

$$E_z = J_m(\gamma_m \rho) e^{im\phi}, E_\rho = -\frac{ik}{2\gamma} \{J_{m-1}(\gamma_m \rho) - J_{m+1}(\gamma_m \rho)\} e^{im\phi}, E_\phi = -\frac{mk}{\gamma^2} J_m(\gamma_m \rho) e^{im\phi}. \text{ In the}$$

$$\text{cladding the fields are } E_z = AK_m(\beta_{m,n} \rho) e^{im\phi}, E_\phi = \frac{ik}{\beta_{m,n}^2} AK_m(\beta_{m,n} \rho) e^{im\phi},$$

$$E_\rho = -\frac{ik}{2\beta_{m,n}} A \{K_{m-1}(\beta_{m,n} \rho) + K_{m+1}(\beta_{m,n} \rho)\} e^{im\phi}, B_\rho = \frac{m\mu_2 \epsilon_2 \omega}{c\beta^2} AK_m(\beta_{m,n} \rho) e^{im\phi},$$

$$B_\phi = -\frac{i\mu_2 \epsilon_2 \omega}{2\beta_{m,n} c} A \{K_{m-1}(\beta_{m,n} \rho) + K_{m+1}(\beta_{m,n} \rho)\} e^{im\phi}. \text{ The approach used in the taper region was that}$$

of solving Helmholtz's equation in oblate spheroidal coordinates in terms of  $\eta$ ,  $\xi$  and  $\phi$ . For a system with  $\phi$  independence we have two coordinates

$$(1 - \xi^2) \frac{\partial^2 \Sigma}{\partial \xi^2} - 2\xi \frac{\partial \Sigma}{\partial \xi} + [(ka\xi)^2 - \chi^2] \Sigma = 0, \text{ and } (1 + \eta^2) \frac{\partial^2 N}{\partial \eta^2} + 2\eta \frac{\partial N}{\partial \eta} + [(k\eta)^2 + \lambda] N = 0. \text{ We}$$

solve for appropriate functions in  $\eta$  and  $\xi$  coordinates. An analysis of slow and fast tapers is presented along with a detailed examination of radiation losses due to tapering.

Phone: 757-727-5923 or 5909

FAX: 757-727-5955

Tech. Monitor: Eric Pencil Phone: 216-977-7463

## GRC HBCU's/OMU's RESEARCH CONFERENCE

### Virtual Instrumentation for a Fiber-Optics-Based Artificial Nerve

Donald R. Lyons and Thet Mon Kyaw  
Hampton University  
Department of Physics  
Hampton, Virginia 23668

#### ABSTRACT

A LabView-based computer interface for fiber-optic artificial nerves has been devised as a Masters thesis project. This project involves the use of outputs from wavelength multiplexed optical fiber sensors (artificial nerves), which are capable of producing dense optical data outputs for physical measurements. The potential advantages of using optical fiber sensors for sensory function restoration is the fact that well defined WDM-modulated signals can be transmitted to and from the sensing region allowing networked units to replace low-level nerve functions for persons desirous of "intelligent artificial limbs." Various FO sensors can be designed with high sensitivity and the ability to be interfaced with a wide range of devices including miniature shielded electrical conversion units. Our Virtual Instrument (VI) interface software package was developed using LabView's "Laboratory Virtual Instrument Engineering Workbench" package. The virtual instrument has been configured to arrange and encode the data to develop an intelligent response in the form of encoded digitized signal outputs. The architectural layout of our nervous system is such that different touch stimuli from different artificial fiber-optic nerve points correspond to gratings of a distinct resonant wavelength and physical location along the optical fiber. Thus, when an automated, tunable diode laser sends scans, the wavelength spectrum of the artificial nerve, it triggers responses that are encoded with different touch stimuli by way wavelength shifts in the reflected Bragg resonances. The reflected light is detected and a resulting analog signal is fed into ADC1 board and DAQ card. Finally, the software has been written such that the experimenter is able to set the response range during data acquisition.

Phone: 757-727-5923 or 5712  
FAX: 757-727-5955  
Tech. Monitor: DeVon Griffin Phone: 216-433-8109

**GRC HBCU's/OMU's RESEARCH CONFERENCE**

**Fiber Bragg Grating Filter High Temperature Sensors**

Donald R. Lyons and Eric D. Brass  
Hampton University  
Department of Physics  
Hampton, Virginia 23668

**ABSTRACT**

We present a scaled-down method for determining high temperatures using fiber-based Bragg gratings. Bragg gratings are distributed along the length of the optical fiber, and have high reflectivities whenever the optical wavelength is twice the grating spacing. These spatially distinct Bragg regions (located in the core of a fiber) are sensitive to local temperature changes. Since these fibers are silica-based they are easily affected by localized changes in temperature, which results in changes to both the grating spacing and the wavelength reflectivity. We exploit the shift in wavelength reflectivity to measure the change in the local temperature. Note that the Bragg region (sensing area) is some distance away from where the temperature is being measured. This is done so that we can measure temperatures that are much higher than the damage threshold of the fiber. We do this by affixing the fiber with the Bragg sensor to a material with a well-known coefficient of thermal expansion, and model the heat gradient from the region of interest to the actual sensor. The research described in this paper will culminate in a working device as well as be the second portion of a publication pending submission to Optics Letters.

Phone: 757-727-5923 or 5712  
FAX: 757-727-5955  
Tech. Monitor: Eric Pencil Phone: 216-977-7463

## GRC HBCU's/OMU's RESEARCH CONFERENCE

### An Algorithm for Interactive Modeling of Space-Transportation Engine Simulations: a Constraint Satisfaction Approach

Debasis Mitra and Ajai Thomas  
Jackson State University  
Department of Computer Science  
P.O. Box 18839  
Jackson, Mississippi 39217

Joseph A. Hemminger and Barbara Sakowski  
NASA Glenn Research Center  
21000 Brookpark Road  
Cleveland, Ohio 44135

#### ABSTRACT

In this research we have developed an algorithm for the purpose of constraint processing by utilizing relational algebraic operators. Van Beek and others have investigated in the past this type of constraint processing from within a relational algebraic framework, producing some unique results. Apart from providing new theoretical angles, this approach also gives the opportunity to use the existing efficient implementations of relational database management systems as the underlying data structures for any relevant algorithm. Our algorithm here enhances that framework. The algorithm is quite general in its current form. Weak heuristics (like forward checking) developed within the *Constraint-satisfaction problem* (CSP) area could be also plugged easily within this algorithm for further enhancements of efficiency. The algorithm as developed here is targeted toward a component-oriented modeling problem that we are currently working on, namely, the problem of interactive modeling for batch-simulation of engineering systems (IMBSES). However, it could be adopted for many other CSP problems as well. The research addresses the algorithm and many aspects of the problem IMBSES that we are currently handling.

Phone: 601-979-2105

FAX: 601-979-2478

Tech. Monitor: Joseph Hemminger Phone: 216-977-7563

**GRC HBCU's/OMU's RESEARCH CONFERENCE****Novel High Efficient Organic Photovoltaic Materials**

Sam Sun, James Haliburton, Zben Fan, Charles Taft, Yiqing Wang, and Shahin Maaref  
Norfolk State University  
Center for Materials Research  
700 Park Avenue  
Norfolk, Virginia 23504

**ABSTRACT**

In man's mission to the outer space or a remote site, the most abundant, renewable, nonpolluting, and unlimited external energy source is light. Photovoltaic (PV) materials can convert light into electrical power. In order to generate appreciable electrical power in space or on the Earth, it is necessary to collect sunlight from large areas due to the low density of sunlight, and this would be very costly using current commercially available inorganic solar cells. Future organic or polymer based solar cells seemed very attractive due to several reasons. These include lightweight, flexible shape, ultra-fast optoelectronic response time (this also makes organic PV materials attractive for developing ultra-fast photo detectors), tunability of energy band-gaps via molecular design, versatile materials synthesis and device fabrication schemes, and much lower cost on large-scale industrial production. It has been predicted that nano-phase separated block copolymer systems containing electron rich donor blocks and electron deficient acceptor blocks will facilitate the charge separation and migration due to improved electronic ultrastructure and morphology in comparison to current polymer composite photovoltaic system. This presentation will describe our recent progress in the design, synthesis and characterization of a novel donor-bridge-acceptor block copolymer system for potential high-efficient organic optoelectronic applications. Specifically, the donor block contains an electron donating alkyloxy derivatized polyphenylenevinylene, the acceptor block contains an electron withdrawing alkyl-sulfone derivatized polyphenylenevinylene, and the bridge block contains an electronically neutral non-conjugated aliphatic hydrocarbon chain. The key synthetic strategy includes the synthesis of each individual block first, then couple the blocks together. While the donor block stabilizes the holes, the acceptor block stabilizes the electrons. The bridge block is designed to hinder the electron-hole recombination. Thus, improved charge separation is expected. In addition, charge migration will also be facilitated due to the expected nano-phase separated and highly ordered block copolymer ultrastructural. The combination of all these factors will result in significant overall enhancement of photovoltaic power conversion efficiency.

Phone: 757-823-2993

FAX: 757-823-9054

Tech. Monitor: Willie R. Mackey Phone: 216-433-8191

**GRC HBCU's/OMU's RESEARCH CONFERENCE**

## Radiation Effects on DC-DC Converters

Dexin Zhang, M.D. Abdul Mazid, and John O. Attia  
Prairie View A&M University  
Department Electrical Engineering  
Prairie View, Texas 77446-0397

**ABSTRACT**

In this work, several DC-DC converters were designed and built. The converters are Buck Buck-Boost, Cuk, Flyback, and full-bridge zero-voltage switched. The total ionizing dose radiation and single event effects on the converters were investigated. The experimental results for the TID effects tests show that the voltages of the Buck Buck-Boost, Cuk, and Flyback converters increase as total dose increased when using power MOSFET IRF250 as a switching transistor. The change in output voltage with total dose is highest for the Buck converter and the lowest for Flyback converter. The trend of increase in output voltages with total dose in the present work agrees with those of the literature. The trends of the experimental results also agree with those obtained from PSPICE simulation. For the full-bridge zero-voltage switch converter, it was observed that the dc-dc converter with IRF250 power MOSFET did not show a significant change of output voltage with total dose. In addition, for the dc-dc converter with FSF254R4 radiation-hardened power MOSFET, the output voltage did not change significantly with total dose. The experimental results were confirmed by PSPICE simulation that showed that FB-ZVS converter with IRF250 power MOSFET's was not affected with the increase in total ionizing dose. Single Event Effects (SEE) radiation tests were performed on FB-ZVS converters. It was observed that the FB-ZVS converter with the IRF250 power MOSFET, when the device was irradiated with Krypton ion with ion-energy of 150 MeV and LET of 41.3 MeV-cm<sup>2</sup>/mg, the output voltage increased with the increase in fluence. However, for Krypton with ion-energy of 600 MeV and LET of 33.65 MeV-cm<sup>2</sup>/mg, and two out of four transistors of the converter were permanently damaged. The dc-dc converter with FSF254R4 radiation hardened power MOSFET's did not show significant change at the output voltage with fluence while being irradiated by Krypton with ion energy of 1.20 GeV and LET of 25.97 MeV-cm<sup>2</sup>/mg. This might be due to fact that the device is radiation hardened.

Phone: 936-857-3923

FAX: 936-857-4780

Tech. Monitor: Mark D. Kankam

Phone: 216-433-6143

534/02 / 11/04 / 100002

**GRC HBCU's/OMU's RESEARCH CONFERENCE**

Research to Significantly Enhance Composite Survivability at 550 °F in Oxidative Environments

Jim Byrd, LaToya Guinn, Kendra Tilley, Laura Carson, and Antoine Carty  
Prairie View A&M University  
P.O. Box 2576  
Prairie View, Texas 77446

**ABSTRACT**

Prairie View A&M University using the NASA FAR grant has embarked on several paths to accomplish the initial goals of (1) synthesizing three ring aromatic diamines to be used as monomers in the synthesis of polyamide resins and (2) study hydrothermal aging behaviors and glass transition changes of composites synthesized at NASA Glenn Research Center. In establishing the synthesis of the three ring aromatic diamine, it has become necessary to conduct preliminary synthesis to include the nitration of diphenylmethane. The concentration and temperature were altered to assess the effect of purity of isomeric product distribution in such electrophilic aromatic substitution reaction. Products were analyzed using H and C-NMR, Thin Layer Chromatography, High Pressure Liquid Chromatography and GC-Mass Spectrometry (in progress). Results indicate that by varying the concentration of the reaction, a mixture of products can be obtained. Other electrophilic aromatic substitution reactions are also in progress such as Friedel Craft acylation reaction using diphenylmethane with 4-nitrobenzoyl chloride to afford other diamine products. Furthermore, PPVAMU has nearly completed the hydrothermal studies to assess the oxidative stability of DSP443B and DSP442A panels formulated at NASA Glenn Research Center.

Phone: 936-857-3914  
FAX: 936-857-2095  
Tech. Monitor: Michael Meador Phone: 216-433-9518

**GRC HBCU's/OMU's RESEARCH CONFERENCE**

## UV Curable Polyimides

Thomas Oliver, Michael Meador, et al.  
Prairie View A&M University  
P.O. Box 2576  
Prairie View, Texas 77446

**ABSTRACT**

The development of UV curable polyimides for high-temperature applications is a growing area of research activity. The objective of this technology is an attempt to bypass many of the issues associated with "typical" high-temperature polymers. For example, the use of toxic or mutagenic monomers (i.e., many aromatic diamines) can be prevented. Also, it proves to be a viable means in circumventing the problems associated with high-processing temperature of polymers, which cause thermally induced processing stresses (i.e., microcracking). The approach that we have been pursuing is Diels-Alder Polymerization. In this approach, we are generating dienes with light instead of heat. This process is called photoenolization. Several bismaleimides and bisacrylates are used as the dienophiles. The method is fairly general and a wide variety of diketones and bismaleimides can be used. UV curability processes are advantageous due to the following: (1) With such a wide variety of monomers, it allows for the use of nontoxic/nonmutagenic monomers. (2) Polyimides cure at room temperature, which reduces thermally induced stresses. (3) It reduces processing and tooling cost. (4) There are many potential applications for this technology, i.e., thin films as alignment layers for LC displays, photoresists, and photonic material as well as a potential market for use as adhesives. Taken from work performed at NASA Glenn Research Center by Michael Meador, Mary Ann Meador, Jennifer Petkovsek, Thomas Oliver, Daniel Scheiman, Christopher Gariepy, Baochau Nguyen, and Ronald Eby.

Phone: 936-857-3914  
FAX: 936-856-2095  
Tech. Monitor: Michael Meador Phone: 216-433-9518

**GRC HBCU's/OMU's RESEARCH CONFERENCE**

Accessibility of NASA Wisdom

John Dyer, Douglas Moreman, and John Coffee  
Southern University  
Baton Rouge, Louisiana, 70813

**ABSTRACT**

Our pursuit of knowledge to preserve has led to a number of retired GRC and Pratt engineers and to Lockheed Martin, Pratt & Whitney, and Boeing personnel. Information in text, audio and video formats has been stored and methods of presenting it in weblike format have been demonstrated. We have gathered from retirees at GRC, knowledge about the causes of launch vehicle failures. Recently through a grant from Marshall Space Flight Center, we have begun to put online several thousand failure analysis reports generated over the last 40 years. Southern University is responsible for incorporating full reports with images, and providing search capabilities. There is no need for commercial database software since a web browser already provides the ability to select text, images, audio, and video for display. We can fine tune the file structure and links and search criteria to the needs of the launch vehicle and propulsion specialists. We have ambitious plans to identify the subdisciplines within rocket propulsion in large bodies of text. A user should be able to specify a few keywords so that the system can identify documents likely to match the user's interest. Our motivation has been, mainly, to preserve rare knowledge of senior engineers who are near retirement. Historical value of such knowledge, and also of our tools, has been pointed out to us by historians. We now propose the application these tools to enhancing communication among groups that are working jointly on a project.

Phone: 225-771-2060  
FAX: 225-771-4223  
Tech. Monitor:

Phone:

**GRC HBCU's/OMU's RESEARCH CONFERENCE****Durability and Damage Development in Woven Ceramic Matrix Composites**

A. Haque, M. Rahman, O. Z. Tyson, and S. Jeelani  
Tuskegee University  
Center for Advanced Materials, Chappie James Building  
Tuskegee, Alabama 36088

**ABSTRACT**

Damage development in woven SiC/SiNC ceramic matrix composites (CMC's) under tensile and cyclic loading both at room and elevated temperatures have been investigated for the exhaust nozzle of high-efficient turbine engines. The ultimate strength, failure strain, proportional limit and modulus data at a temperature range of 23 to 1250 °C are generated. The tensile strength of SiC/SiNC woven composites have been observed to increase with increased temperatures up to 1000 °C. The stress/strain plot shows a pseudo-yield point at 25 percent of the failure strain ( $\epsilon_f$ ) which indicates damage initiation in the form of matrix cracking. The evolution of damage beyond 0.25  $\epsilon_f$  both at room and elevated temperature comprises multiple matrix cracking, interfacial debonding, and fiber pullout. Although the nature of the stress/strain plot shows damage-tolerant behavior under static loading both at room and elevated temperature, the life expectancy of SiC/SiNC composites degrades significantly under cyclic loading at elevated temperature. This is mostly due to the interactions of fatigue damage caused by the mechanically induced plastic strain and the damage developed by the creep strain. The in situ damage evolutions are monitored by acoustic event parameters, ultrasonic C-scan and stiffness degradation. Rate equations for modulus degradation and fatigue life prediction of ceramic matrix composites both at room and elevated temperatures are developed. These rate equations are observed to show reasonable agreement with experimental results.

Phone: 334-727-8039  
FAX: 334-727-8801  
Tech. Monitor: Michael J. Verrilli Phone: 216-433-3337

**GRC HBCU's/OMU's RESEARCH CONFERENCE**

**Notch Sensitivity of Woven Ceramic Matrix Composites Under Tensile Loading—  
An Experimental, Analytical, and Finite Element Study**

A. Haque, L. Ahmed, T. Ware, and S. Jeelani  
Tuskegee University  
Center for Advanced Materials, Chappie James Building  
Tuskegee, Alabama 36088

**ABSTRACT**

The stress concentrations associated with circular notches and subjected to uniform tensile loading in woven ceramic matrix composites (CMC's) have been investigated for high-efficient turbine engine applications. The CMC's were composed of Nicalon silicon carbide woven fabric in SiNC matrix manufactured through polymer impregnation process (PIP). Several combinations of hole diameter/plate width ratios and ply orientations were considered in this study. In the first part, the stress concentrations were calculated measuring strain distributions surrounding the hole using strain gages at different locations of the specimens during the initial portion of the stress-strain curve before any microdamage developed. The stress concentration was also calculated analytically using Lekhnitskii's solution for orthotropic plates. A finite-width correction factor for anisotropic and orthotropic composite plate was considered. The stress distributions surrounding the circular hole of a CMC's plate were further studied using finite element analysis. Both solid and shell elements were considered. The experimental results were compared with both the analytical and finite element solutions. Extensive optical and scanning electron microscopic examinations were carried out for identifying the fracture behavior and failure mechanisms of both the notched and unnotched specimens. The stress concentration factors (SCF) determined by analytical method overpredicted the experimental results. But the numerical solution underpredicted the experimental SCF. Stress concentration factors are shown to increase with enlarged hole size and the effects of ply orientations on stress concentration factors are observed to be negligible. In all the cases, the crack initiated at the notch edge and propagated along the width towards the edge of the specimens.

Phone: 334-727-8039  
FAX: 334-727-8801  
Tech. Monitor: Michael J. Verrilli Phone: 216-433-3337

**GRC HBCU's/OMU's RESEARCH CONFERENCE****Long-Term Creep and Creep Rupture Behavior of Woven Ceramic Matrix Composites**

A. Haque, M. Rahman, A. Mach, and S. Jeelani  
Tuskegee University  
Center for Advanced Materials, Chappie James Building  
Tuskegee, Alabama 36088

**ABSTRACT**

Tensile creep behavior of SiC/SiNC ceramic matrix composites at elevated temperatures and at various stress levels have been investigated for turbine engine applications. The objective of this research is to present creep behavior of SiC/SiCN composites at stress levels above and below the monotonic proportional limit strength and predict the life at creep rupture conditions. Tensile creep-rupture tests were performed on an Instron 8502 servohydraulic testing machine at constant load conditions up to a temperature limit of 1000 °C. Individual creep curves indicate three stages such as primary, secondary, and tertiary. The creep rate increased linearly at an early stage and then gradually became exponential at higher strains. The stress exponent and activation energy were also obtained at 700 and 1000 °C. The specimen lifetime was observed to be 55 hrs at 121 MPa and at 700 °C. The life span reduced to 35 hrs at 143 MPa and at 1000 °C. Scanning electron microscopy observations revealed significant changes in the crystalline phases and creep damage development. Creep failures were accompanied by extensive fiber pullout, matrix cracking, and debonding along with fiber fracture. The creep data was applied to Time-Temperature-Stress superposition model and the Manson-Haferd parametric model for long-time life prediction.

Phone: 334-727-8039  
FAX: 334-727-8801  
Tech. Monitor: Michael J. Verrilli Phone: 216-433-3337

## GRC HBCU's/OMU's RESEARCH CONFERENCE

Polyimide Based Nanocomposites for Affordable Space Transport

Derrick Dean, Mohsina Islam, Sharee Small, and Brandon Aldridge  
Tuskegee University  
Department of Mechanical Engineering Center for Advanced Materials  
101 Chappie James Center  
Tuskegee, Alabama 36088

### ABSTRACT

In setting forth its strategic plan, NASA has indicated that low-cost access to space is the key to unleashing the commercial potential of space and greatly expanding space research and exploration. The development of advanced materials will be an enabling technology for this quest for low-cost space access. In this research program, we are attempting to address the need for new advanced materials by developing high-performance nanodispersed inorganic/organic and organic/organic polyimide composites utilizing specific interactions. Our goal is to systematically manipulate these interactions and investigate the resulting processing morphology-property relationships. Specifically, we will investigate three main parameters on these relationships. These include (1) the type of polyimide, (2) the structure of the inorganic nanoparticle being used, and (3) manipulation of the interfacial energy. During the first year of this effort, we have demonstrated the successful synthesis of PMR-15/layered silicate nanocomposites. Morphological studies indicate that exfoliated structures were obtained in most instances, with a mixture of exfoliated and intercalated structures being observed also. Significant enhancements of the onset of decomposition were obtained by varying the strength of the interaction between the nanoparticle and the polymer. Varying the amount of a specific nanoparticle also affected the decomposition temperatures. A slight catalytic effect of the nanoparticles on both the imidization and crosslinking reaction has been observed and will be presented. In addition, incorporation of the nanoparticles was found to increase the glass transition temperature and slightly broaden the breadth of this relaxation.

Phone: 334-727-4247

FAX: 334-727-8801

Tech. Monitor: Sandra G. Campbell Phone: 216-433-8489

**GRC HBCU's/OMU's RESEARCH CONFERENCE**

**Study of Electrical Contacts and Devices in Advanced Semiconductors**

H.P. Hall and K. Das  
Tuskegee University  
Electrical Engineering Department  
Tuskegee, Alabama 36088

**ABSTRACT**

Research conducted at Tuskegee University concentrates on electrical contacts to GaN films and their characterization with the objective of understanding contact formation and realizing low-resistance metal contacts. Contact properties are known to be strongly related to surface preparation. It appears that the as-received material had a thin oxide film on the surface of the GaN film. Various cleaning treatments were employed in order to render the surface contamination free and removal of the oxide film. Metal films were then deposited by e-beam evaporation. Electrical characteristics of these contacts indicated that the optimal treatment was an organic solvent cleaning followed by etching in buffered oxide solution. Contacts established with Al were observed to be ohmic in nature, whereas Au, Cr, Ti, and Pt exhibit rectifying contacts. Platinum contacts were almost ideal as shown by an ideality factor of 1.02.

Phone: 334-727-8994  
FAX: 334-724-4806  
Tech. Monitor: Samuel Alterovitz Phone: 216-433-3517

**GRC HBCU's/OMU's RESEARCH CONFERENCE**

**Kelvin Probe Measurements on Solar Cells and Other Thin Film Devices**

John Delk, D.W. Dils, and G.B. Lush  
University of Texas at El Paso  
Department of Electrical and Computer Engineering  
500 West University Avenue  
El Paso, Texas 79968

**ABSTRACT**

The Kelvin Probe (KP) has been used for years to measure the surface potential of metals and semiconductors. The KP is an elegantly simple but powerful tool invented by Lord Kelvin around the turn of the century. Using changes in surface potentials as a result of changing the intensity and wavelength of illumination, the KP returns data on material parameters such as band gap energies and the energy levels of interface states. We have employed the KP in the study of CdTe-based solar cells and quantum dot-based solar cells, as well as other thin-film devices. We hope eventually that the KP will be used as an in-line testing station for a fabrication process so that unfinished devices that will not meet requirements can be thrown out before the processing is completed, thus saving resources. Results of these studies will be presented.

Phone: 915-747-6632  
FAX: 915-747-7871  
Tech. Monitor: Willie R. Mackey Phone: 216-433-8191

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**GRC HBCU's/OMU's RESEARCH CONFERENCE**

**Annealing of Solar Cells and Other Thin Film Devices**

Hector Escobar, Franz Kuhlmann, D.W. Dils, and G.B. Lush  
University of Texas at El Paso  
Department of Electrical and Computer Engineering  
500 West University Avenue  
El Paso, Texas 79968

**ABSTRACT**

Annealing is a key step in most semiconductor fabrication processes, especially for thin films where annealing enhances performance by healing defects and increasing grain sizes. We have employed a new annealing oven for the annealing of CdTe-based solar cells and have been using this system in an attempt to grow CdS on top of CdTe by annealing in the presence of H<sub>2</sub>S gas. Preliminary results of this process on CdTe solar cells and other thin-film devices will be presented.

Phone: 915-747-6632  
FAX: 915-747-7871  
Tech. Monitor: Willie R. Mackey Phone: 216-433-8191

**GRC HBCU's/OMU's RESEARCH CONFERENCE**

**Reliability of a Series Pipe Network**

Rodney Harris  
University of Texas at San Antonio  
6900 North Loop 1604 W.  
San Antonio, Texas 78249

**ABSTRACT**

The goal of this NASA-funded research is to advance research and education objectives in theoretical and computational probabilistic structural analysis, reliability, and life prediction methods for improved aerospace and aircraft propulsion system components. Reliability methods are used to quantify response uncertainties due to inherent uncertainties in design variables. In this report, several reliability methods are applied to a series pipe network. The observed responses are the head delivered by a main pump and the line head at a desired flow rate. The probability that the flow rate in the line will be less than a specified minimum will be discussed.

Phone: 210-458-5522

FAX: 210-458-5586

Tech. Monitor: Christopher Chamis Phone: 216-433-3252

**GRC HBCU's/OMU's RESEARCH CONFERENCE**

Reliability of a Parallel Pipe Network

Edgar Herrera  
University of Texas at San Antonio  
6900 North Loop 1604 W.  
San Antonio, Texas 78249

**ABSTRACT**

The goal of this NASA-funded research is to advance research and education objectives in theoretical and computational probabilistic structural analysis, reliability, and life prediction methods for improved aerospace and aircraft propulsion system components. Reliability methods are used to quantify response uncertainties due to inherent uncertainties in design variables. In this report, several reliability methods are applied to a parallel pipe network. The observed responses are the head delivered by a main pump and the head values of two parallel lines at certain flow rates. The probability that the flow rates in the lines will be less than their specified minimums will be discussed.

Phone: 210-458-5522

FAX: 210-458-5586

Tech. Monitor: Christopher Chamis Phone: 216-433-3252

## **GRC HBCU's/OMU's RESEARCH CONFERENCE**

### **Generic Divide and Conquer Internet-Based Computing**

Atanas Radenski  
Winston-Salem State University  
Computer Science Department  
501 M.L. King Jr. Drive  
Winston-Salem, North Carolina 27110

#### **ABSTRACT**

The rapid growth of internet-based applications and the proliferation of networking technologies have been transforming traditional commercial application areas as well as computer and computational sciences and engineering. This growth stimulates the exploration of new, internet-oriented software technologies that can open new research and application opportunities not only for the commercial world, but also for the scientific and high-performance computing applications community. The general goal of this research project is to contribute to better understanding of the transition to internet-based high-performance computing and to develop solutions for some of the difficulties of this transition. More specifically, our goal is to design an architecture for generic divide and conquer internet-based computing, to develop a portable implementation of this architecture, to create an example library of high-performance divide-and-conquer computing agents that run on top of this architecture, and to evaluate the performance of these agents. We have been designing an architecture that incorporates a master task-pool server and utilizes satellite computational servers that operate on the Internet in a dynamically changing large configuration of lower-end nodes provided by volunteer contributors. Our designed architecture is intended to be complementary to and accessible from computational grids such as Globus, Legion, and Condor. Grids provide remote access to existing high-end computing resources; in contrast, our goal is to utilize idle processor time of lower-end internet nodes. Our project is focused on a generic divide-and-conquer paradigm and its applications that operate on a loose and ever changing pool of lower-end internet nodes.

Phone: 336-750-2478

FAX: 336-750-2499

Tech. Monitor: Gregory J. Follen Phone: 216-433-5193

OMIT TO END

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**WHY COSTING IS IMPORTANT ON HBCU GRANTS**

## WHY IS COST IMPORTANT?

### **COST**

IS OUR ONLY FISCAL MEASURE OF ACTUAL WORK ACCOMPLISHMENT. IT CAN BE UTILIZED BY MANAGEMENT TO EVALUATE THE EFFICIENCY & EFFECTIVENESS OF BUDGET EXECUTION ON OUR PROGRAMS.

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## WHAT DOES FORWARD FUNDING MEAN?

### **FORWARD FUNDING**

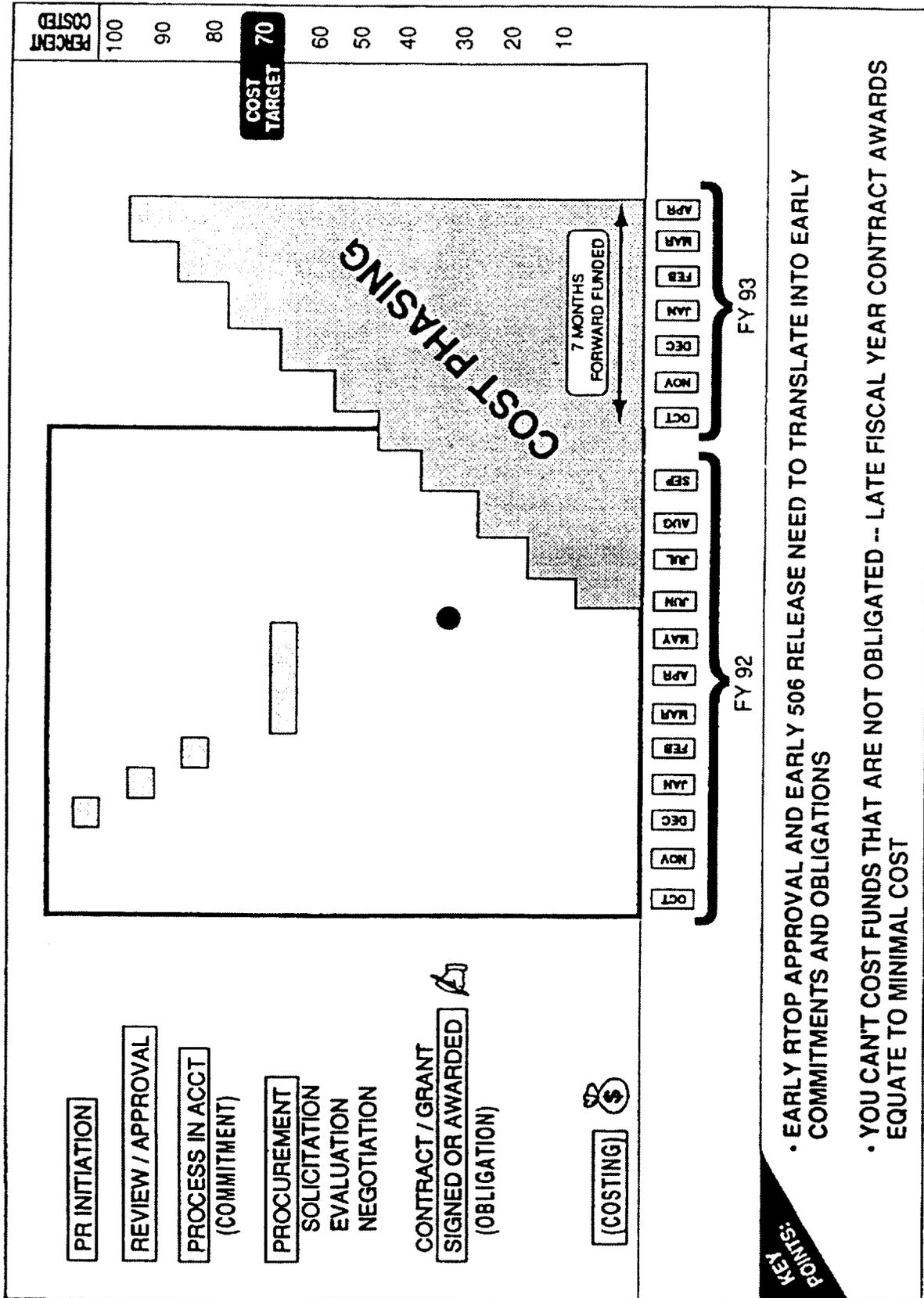
IS EXPRESSED AS EITHER

① THE AMOUNT OF FUNDING THAT ONE'S PROGRAM OR CONTRACT WILL NOT "COST" DURING THE CURRENT FISCAL YEAR. OR

② THE PERIOD OF TIME THAT YOUR CONTRACT IS FORWARD FUNDED INTO THE NEXT FISCAL YEAR.  
(NOTE: RB'S GUIDELINE IS THAT FORWARD FUNDING BE LIMITED TO NO MORE THAN 2 MONTHS ON ALL OAST CONTRACTS)

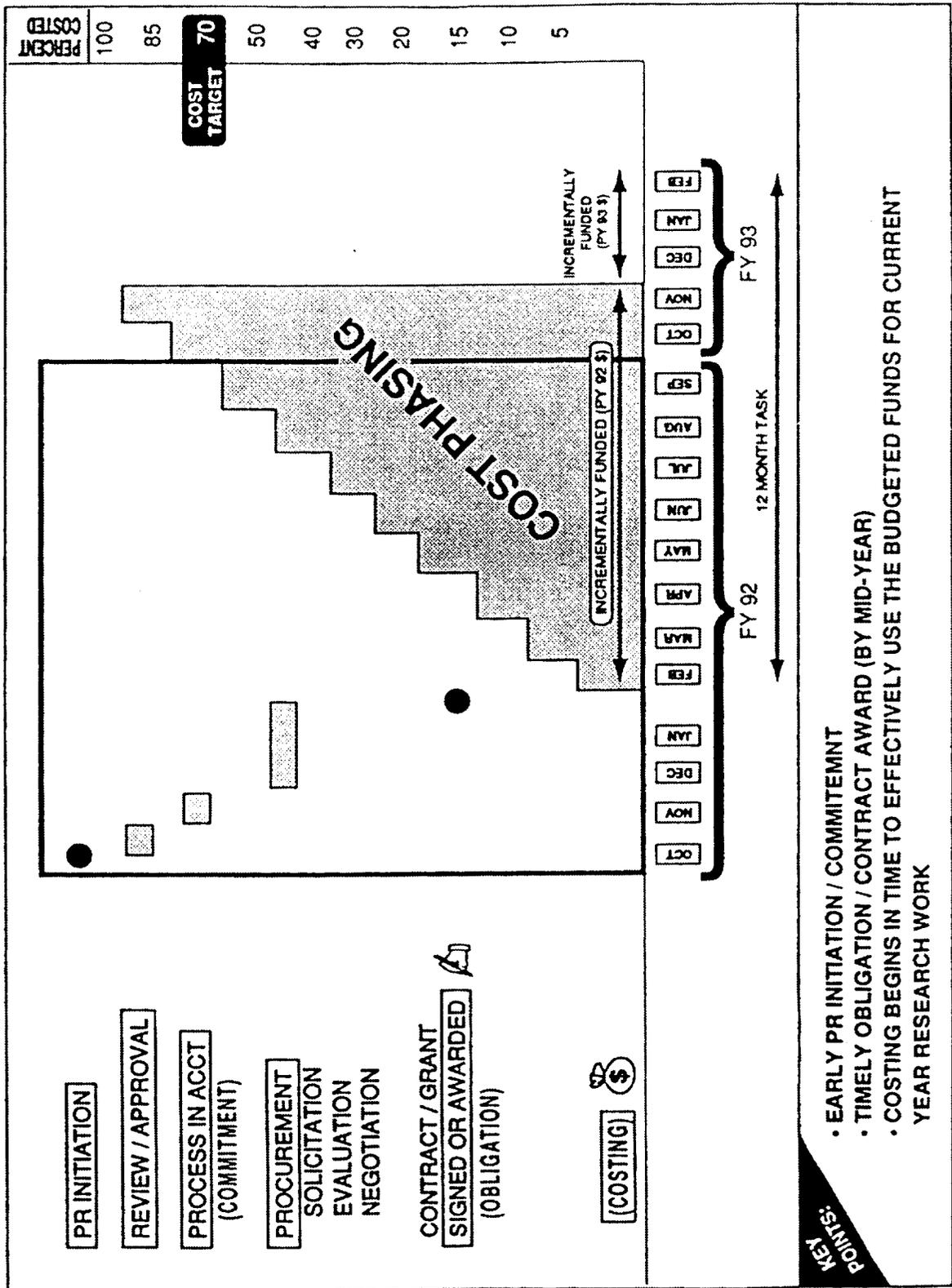
## **WHY COSTING IS IMPORTANT ON HBCU GRANTS**

# EXAMPLE OF POOR COST MANAGEMENT



- KEY POINTS:**
- EARLY RTOP APPROVAL AND EARLY 506 RELEASE NEED TO TRANSLATE INTO EARLY COMMITMENTS AND OBLIGATIONS
  - YOU CAN'T COST FUNDS THAT ARE NOT OBLIGATED -- LATE FISCAL YEAR CONTRACT AWARDS EQUATE TO MINIMAL COST

# EXAMPLE OF GOOD COST MANAGEMENT



# COST MANAGEMENT

## ☒ CHECKING ACCOUNT ANALOGY ☒

- CODE R POLICY ALLOWS 2 MONTHS OF FORWARD FUNDING ON CONTRACTS (BEYOND 9/30) AND A CARRYOVER OF 30% OF YOUR BUDGET ALLOCATION TO COVER EXPENDITURES IN THE FOLLOWING FISCAL YEAR
- HOW MANY MONTHS OF FORWARD FUNDING DO YOU MAINTAIN IN YOUR PERSONAL CHECKING ACCOUNT?
- FLIGHT CENTERS AND MAJOR AGENCY PROGRAMS OPERATE WITH LESS THAN 2 WEEKS OF FORWARD FUNDING INTO THE FOLLOWING FISCAL YEAR
- EXTERNAL AUDIT ORGANIZATIONS CAN'T UNDERSTAND WHY WE ASK FOR FUNDS IN OUR BUDGET REQUEST THAT WE WON'T SPEND IN THE CURRENT FISCAL YEAR.



## Cost Management

- NASA MUREP
  - At least 80% of funds should be costed by the end of Federal fiscal year (September 30)
- NASA MUREP Grantees
  - Incremental funding of large \$ value grants or cooperative agreements
  - Minimize forward funding beyond 2 months into the following fiscal year
  - 100% of funds should be encumbered by the end of the grant year; funds not encumbered will be deducted from the first incremental funding, actual carryover will be deducted from the second incremental funding

# How Can I Improve My Program's Cost Performance

## RB Recommendations

- ① Timelier initiation of procurements
  - "Long leadtime" acquisitions (1st Qtr)
  - Planning PR's / initiations use while awaiting 506 (1st Qtr)
  - Small purchases / off-the-shelf buys (2nd Qtr)
  - Tasks on Support Service Contracts (1st Half of Year)
- ② Expanded use of "Incremental Funding" of Contracts
  - Recommended 2 actions per year (1-1st Qtr; 2-Midyear)
  - Avoid multiyear / 100% funding up-front scenarios
  - Use incremental funding on major fixed-price contracts also
- ③ Limit forward funding on incrementally-funded contracts (or major tasks on Support Service Contracts) to only one month
- ④ Implement a one-time adjustment to start dates on major grants / contracts that are not incrementally funded (startup in 1st Qtr, NOT 4th Qtr)
- ⑤ Ensuring that all legitimate accrued cost on your program is recorded in your Center fiscal systems in a timely and accurate manner
- ⑥ Base Budget Requests upon how much \$ your program will be able to cost over the 12/1/97 - 12/1/98 time frame



Office of Aeronautics  
National Aeronautics and Space Administration

226-Cost Mgmt. 10/6/96.EH

## **RECOMMENDATION**

- **SUBMIT ALL NECESSARY INFORMATION BILLING TO YOUR COLLEGE FINANCE, ACCOUNTING, OR BILLING OFFICES ON A TIMELY BASIS (AT LEAST ONCE PER MONTH).**
- **INSURE THAT YOUR COLLEGE BILLING OFFICE SUBMITS REQUIRED BILLING INFORMATION TO NASA LEWIS EACH MONTH SO THAT LEWIS MAY PROPERLY REFLECT ACCURATE UP-TO-DATE COSTING ON YOUR HBCU GRANT.**



## Donald J. Campbell

Donald J. Campbell is Director of the National Aeronautics and Space Administration's Glenn Research Center in Cleveland, Ohio. He was appointed to this position by NASA Administrator Daniel Goldin on January 6, 1994.

As Director, Mr. Campbell is responsible for planning, organizing, and directing the activities required to accomplish the missions assigned to the Center. Glenn is engaged in research, technology, and systems development programs in aeronautical propulsion, space propulsion, space power, and space sciences/applications. Campbell is responsible for the day-to-day management of these programs, which involve an annual budget of approximately \$1 billion, just under 2800 civil service employees and 2000 support service contractors, and more than 500 specialized research facilities located near Cleveland Hopkins International Airport and at Plum Brook Station in Sandusky, Ohio.

Campbell earned a bachelor's degree in mechanical engineering from Ohio Northern University, a master's degree in mechanical engineering and did predoctoral work at Ohio State University. He completed the Senior Executive Seminar in Management at Carnegie Mellon School of Urban and Public Affairs and the Federal Executive Institute Executive Leadership program. He also completed several senior management courses at Brookings Institute.

Campbell began his government career in 1960 as a test engineer for gas turbine engines and engine components in the Air Force Aero Propulsion Laboratory, Wright-Patterson Air Force Base, Ohio. He then worked as a project engineer and later as a program manager for advanced airbreathing propulsion systems.

From February to July 1986, Campbell was assigned as an interim Directorate Chief during the implementation of the National Aerospace Plane (NASP) Program Office, Wright-Patterson Air Force Base. He was Acting Director of the NASP Technology Maturation Directorate. In 1987, he became Acting Deputy Director of the Aero Propulsion Laboratory. In 1988, he was selected for the rank of Senior Executive Service and was appointed Deputy Program Director for the Propulsion System Program Office, Aeronautical Systems Division. He was the senior civilian executive for development and acquisition of new and derivative gas turbine engines for operational aircraft. In 1990, he was appointed Director of the Aero Propulsion and Power Laboratory. He was responsible for the Air Force propulsion and power research and development in the areas of gas turbine engines, ramjet engines, aerospace power systems, and fuels and lubricants.

In 1992, he was named Director of Science and Technology, Office of the Assistant Secretary of the Air Force for Acquisition, Washington, D.C. In this capacity he monitored the Air Force Science and Technology program and other selected research, development, technology, and engineering programs.

Campbell and his wife, Helen, have four children.

## Dr. Julian M. Earls

Dr. Julian M. Earls, Deputy Director for Operations at the NASA John H. Glenn Research Center at Lewis Field, is a native of Portsmouth, Virginia. He earned the Bachelor's Degree, with distinction, in Physics from Norfolk State University; the Master's Degree in Radiation Physics from the University of Rochester School of Medicine; and the Doctorate Degree in Radiation Physics from the University of Michigan. He also earned the equivalent of a second Master's Degree in Environmental Health from the University of Michigan and is a graduate of the Harvard Business School's prestigious Program for Management Development. In addition, he was awarded the Honorary Doctor of Science degree by the College of Aeronautics in New York.

He has 21 publications, both technical and educational. He has been Distinguished Honors Visiting Professor at numerous universities throughout the Nation. On two separate occasions, he has been awarded NASA medals for exceptional achievement and outstanding leadership. In addition, he has received the Presidential Rank Award of Meritorious Executive. Dr. Earls is a Jennings Foundation Distinguished Scholar Lecturer.

Dr. Earls is co-founder of an organization whose members make personal contributions for scholarships to black students who attend historically black colleges and universities. He has served on many university Boards of Trustees and is a member of the Advisory Board for the Rock and Roll Hall of Fame. He was inducted into the inaugural class of the National Black College Alumni Hall of Fame, with such distinguished individuals as Dr. Martin Luther King, Jr., and Justice Thurgood Marshall.

He holds life memberships in the NMCP and Kappa Alpha Psi Fraternity. He is an avid runner who has run over 10,000 miles in the past 5 years and successfully completed 22 marathons, including the Boston Marathon.

Dr. Earls is married to the former Zenobia Gregory of Norfolk, Virginia, a former Reading Specialist in the Cleveland School System. They have two sons: Julian, Jr., is a neurologist who graduated from Howard University and Case Western Reserve University Medical School; Gregory is a filmmaker who graduated from Norfolk State University and the American Film Institute in Hollywood, California.

## Dr. Sunil Dutta

Dr. Sunil Dutta is Program Manager for Small Disadvantaged Businesses (SDBs) at the National Aeronautics and Space Administration's Glenn Research Center, Cleveland, Ohio. Appointed to this position in 1992, he is responsible for implementing policies that ensure the Small Disadvantaged Businesses (SDBs) and Historically Black Colleges and Universities (HBCUs) are encouraged and afforded an equitable opportunity to compete for NASA contracts and research grants. The goal is to increase R&D contracts with SDBs and research grants with HBCUs at Glenn Research Center. Before assuming the present position, his career has been devoted to research and development of materials science and technology, particularly in the area of processing, characterization, and mechanical behavior of high performance ceramics and ceramics matrix composites, for heat engines and high speed civil transport applications. In addition, he monitored numerous R&D contracts and grants for more than 10 years as project/program manager.

Dr. Dutta joined NASA Glenn Research Center in 1976 after 8 years at the U.S. Army Technology Laboratory, Watertown, Massachusetts. Born in India, he received his B.Sc (Hons), and M.S. from Calcutta University, and M.S. and Ph.D. from the University of Sheffield, England. He also received an MBA degree from Babson College, Wellesley, Massachusetts.

Dr. Dutta has written more than 50 publications including 4 patents and 5 chapters in books.

He is a Fellow of the American Ceramic Society, and the Institute of Ceramics in England. He is listed in American Men and Women in Science, Who's Who in Engineering, and Who's Who in the United States.

Dr. Dutta was invited to Japan for one year as Nippon Steel Endowed Chair Visiting Full Professor, at the University of Tokyo's Research Center for Advanced Science & Technology. Since 1987, he visited Germany, Japan, Korea, Singapore, Australia, and India to present invited technical papers/lectures. Also, actively consulted for industry and government including the CSIR (Council of Scientific and Industrial Research) laboratories in India, under the United Nations Development Program (UNDP).

He has actively participated in Local School PTA programs, as Vice-president of Canterbury Homeowners Association, as President of India Association in Boston, Massachusetts, and in Cleveland, Ohio; and co-convenor of 5th biennial National Convention of All Asian-Indians in North America.

Dr. Dutta and his wife Kabita reside in Westlake, Ohio. They have three children.



## HBCUs/OMUs RESEARCH CONFERENCE

### List of Attendees April 17-18, 2001

**Casey Alexander**  
Hampton University  
Hampton, VA 23668

Phone 757-727-5741  
Fax 757-727-5189  
E-mail ixcel@hotmail.com

**Samuel Alterovitz**  
NASA Glenn Research Center  
21000 Brookpark Road  
MS 54-5  
Cleveland, OH 44135  
Phone 216-433-3517  
Fax 216-433-8705  
E-mail alterovitz@grc.nasa.gov

**Bradley Baker**  
NASA Glenn Research Center  
21000 Brookpark Road  
MS 500-313  
Cleveland, OH 44135  
Phone 216-433-2800  
Fax  
E-mail Bradley.J.Baker@grc.nasa.gov

**Bruce A. Banks**  
NASA Glenn Research Center  
21000 Brookpark Road  
MS 309-2  
Cleveland, OH 44135  
Phone 216-433-2308  
Fax 216-433-8000  
E-mail Bruce.A.Banks@grc.nasa.gov

**Renee Batts**  
NASA Glenn Research Center  
21000 Brookpark Road  
MS 500-311  
Cleveland, OH 44135  
Phone 216-433-3081  
Fax 216-433-8285  
E-mail Renee.J.Batts@grc.nasa.gov

**Thomas Biesiadny**  
NASA Glenn Research Center  
21000 Brookpark Road  
MS 86-7  
Cleveland, OH 44135  
Phone 216-433-3967  
Fax  
E-mail Thomas.Biesiadny@grc.nasa.gov

**Dean Bitler**  
NASA Glenn Research Center  
21000 Brookpark Road  
MS 23-2  
Cleveland, Ohio 44135  
Phone 216-433-2226  
Fax  
E-mail Dean.Bitler@grc.nasa.gov

**Virginia Bittinger**  
NASA Glenn Research Center  
21000 Brookpark Road  
MS 500-313  
Cleveland, OH 44135  
Phone 216-433-2755  
Fax  
E-mail virginia.bittinger@grc.nasa.gov

**Isaiah Blankson**  
NASA Glenn Research Center  
21000 Brookpark Road  
MS 5-9  
Cleveland, OH 44135  
Phone 216-433-5823  
Fax  
E-mail blankson@grc.nasa.gov

**Richard Blech**  
NASA Glenn Research Center  
21000 Brookpark Road  
MS 5-11  
Cleveland, OH 44135  
Phone 216-433-3657  
Fax 216-433-5802  
E-mail richard.a.blech@grc.nasa.gov

**Thomas Bond**  
NASA Glenn Research Center  
21000 Brookpark Road  
MS 11-2  
Cleveland, OH 44135  
Phone 216-433-3900  
Fax 216-977-7469  
E-mail tbond@grc.nasa.gov

**Marie Borowski**  
NASA Glenn Research Center  
21000 Brookpark Road  
MS 7-4  
Cleveland, OH 44135  
Phone 216-433-5582  
Fax  
E-mail marie.borowski@grc.nasa.gov

**Eric Brass**  
Hampton University  
Hampton, VA 23668  
Phone 757-727-5923  
Fax 757-727-5955  
E-mail brass.eric@lycos.com

**Delbert Buffinger**  
Wilberforce University  
1055 North Bickett Road  
Wilberforce, OH 45384  
Phone 937-376-2911, x659  
Fax  
E-mail dbuffing@wilberforce.edu

**Leo Burkardt**  
NASA Glenn Research Center  
21000 Brookpark Road  
MS 86-1  
Cleveland, OH 44135  
Phone 216-977-7021  
Fax 216-977-7008  
E-mail leo.a.burkardt@grc.nasa.gov

**Donald Campbell**  
Director, NASA Glenn Research Center  
21000 Brookpark Road  
MS 3-2  
Cleveland, OH 44135  
Phone 216-433-2929  
Fax  
E-mail donald.campbell@grc.nasa.gov

**Sandi Campbell**  
NASA Glenn Research Center  
21000 Brookpark Road  
MS 49-3  
Cleveland, OH 44135  
Phone 216-433-8489  
Fax 216-433-8000  
E-mail sand.campbell@grc.nasa.gov

**Laura Carson**  
Prairie View A&M University  
P.O. Box 667  
Prairie View, TX 77446  
Phone 936-857-3914  
Fax 936-857-2095  
E-mail laura\_carson@pvamu.edu

**Antoine Carty**

Prairie View A&M University  
P.O. Box 667  
Prairie View, TX 77446

Phone 936-857-3914  
Fax 936-857-2095  
E-mail antoine\_carty@pvamu.edu

**Derrick Cheston**

NASA Glenn Research Center/  
Ohio Aerospace Institute  
22800 Cedar Point Road  
Cleveland, OH 44142  
Phone 216-433-3879  
Fax  
E-mail cheston.j.derrick@oai.org

**Emmanuel Collins**

Florida A&M University  
2525 Pottsdamer Street  
Tallahassee, FL 32310

Phone 850-410-6373  
Fax 850-410-6337  
E-mail ecollins@eng.fsu.edu

**Michael Curley**

Alabama A&M University  
4900 Meridian Street  
P.O. Box 1268  
Normal, AL 35762  
Phone 256-858-8236  
Fax 256-851-8560  
E-mail mcurley@aamu.edu

**Kalyan Kumar Das**

Tuskegee University  
Tuskegee, AL 36088

Phone 334-727-8994  
Fax 334-724-4806  
E-mail dask@acd.tusk.edu

**David Davis**

NASA Glenn Research Center  
21000 Brookpark Road  
MS 86-7  
Cleveland, OH 44135  
Phone 216-433-8116  
Fax  
E-mail david.o.davis@grc.nasa.gov

**John Delk**

University of Texas at El Paso  
500 West University Avenue  
El Paso, TX 79968-0587

Phone 915-747-6632  
Fax 915-747-7871  
E-mail klednhoj@elp.rr.com

**Cindy Dreibelbis**

NASA Glenn Research Center  
21000 Brookpark Road  
MS 3-7  
Cleveland, OH 44135  
Phone 216-433-2912  
Fax 216-433-5531  
E-mail cldreibelbis@grc.nasa.gov

**Sunil Dutta**

NASA Glenn Research Center  
21000 Brookpark Road  
MS 3-9  
Cleveland, OH 44135  
Phone 216-433-8844  
Fax 216-433-5266  
E-mail sunil.dutta@grc.nasa.gov

**Walter Duval**

NASA Glenn Research Center  
21000 Brookpark Road  
MS 105-1  
Cleveland, OH 44135  
Phone 216-433-5023  
Fax  
E-mail walter.m.duval@grc.nasa.gov

**Julian Earls**

NASA Glenn Research Center  
21000 Brookpark Road  
MS 3-9  
Cleveland, OH 44135  
Phone 216-433-3014  
Fax 216-433-5266  
E-mail Julian.M.Earls@grc.nasa.gov

**Dennis Eichenberg**

NASA Glenn Research Center  
21000 Brookpark Road  
MS 86-5  
Cleveland, OH 44135  
Phone 216-433-8360  
Fax  
E-mail dennis.j.eichenberg@grc.nasa.gov

**Abdalla Elsamadicy**

Alabama A&M University  
P.O. Box 1447  
Normal, AL 35762-1447

Phone 256-851-5872  
Fax 256-851-5868  
E-mail abdalla@cim.aamu.edu

**Leon Fabick**

ITN Energy Systems  
Littleton, CO

Phone  
Fax  
E-mail fabick@itnes.com

**Aisha Fields**

Alabama A&M University  
Physics Dept.  
P.O. Box 1447  
Normal, AL 35762-1447  
Phone 256-851-5305  
Fax  
E-mail afields@aamu.edu

**Gregory Follen**

NASA Glenn Research Center  
21000 Brookpark Road  
MS 142-5  
Cleveland, OH 44135  
Phone 216-433-5193  
Fax  
E-mail gregory.j.follen@grc.nasa.gov

**Clark Fuller**

Central State University  
1400 Brush Row Road  
Wilberforce, OH 45384  
Phone 937-376-6312  
Fax 937-376-6598  
E-mail cfuller@prodigy.net

**Randall Furnas**

NASA Glenn Research Center  
21000 Brookpark Road  
MS 3-1  
Cleveland, OH 44135  
Phone 216-433-2321  
Fax  
E-mail randall.furnas@grc.nasa.gov

**John Gaff**

NASA Glenn Research Center  
21000 Brookpark Road  
MS 3-2  
Cleveland, OH 44135  
Phone 216-433-2940  
Fax  
E-mail j.w.gaff@grc.nasa.gov

**Daniel Gauntner**

NASA Glenn Research Center  
21000 Brookpark Road  
MS 86-15  
Cleveland, OH 44135  
Phone 216-433-3254  
Fax 216-433-2215  
E-mail daniel.gauntner@grc.nasa.gov

**Mikhail Gilinsky**

Hampton University  
Hampton, VA 23668

Phone 757-727-5741  
Fax 757-727-5189  
E-mail mikhail.gillinsky@hampton.edu

**Marvin Goldstein**

NASA Glenn Research Center  
21000 Brookpark Road  
MS 3-17  
Cleveland, OH 44135  
Phone 216-433-5825  
Fax 216-433-5531  
E-mail marvin.e.goldstein@grc.nasa.gov

**Susan Gott**

NASA Glenn Research Center  
21000 Brookpark Road  
MS 7-4  
Cleveland, OH 44135  
Phone 216-433-3833  
Fax  
E-mail susan.f.gott@grc.nasa.gov

**Leslie Greenbauer-Seng**

NASA Glenn Research Center  
21000 Brookpark Road  
MS 106-1  
Cleveland, OH 44135  
Phone 216-433-6781  
Fax  
E-mail  
leslie.a.greenbauer-seng@grc.nasa.gov

**John Gyekenyesi**

NASA Glenn Research Center  
21000 Brookpark Road  
MS 49-7  
Cleveland, OH 44135  
Phone 216-433-3210  
Fax 216-433-8300  
E-mail john.p.gyekenyesi@grc.nasa.gov

**Jeffrey Haas**

NASA Glenn Research Center  
MS 21-2  
21000 Brookpark Road  
Cleveland, OH 44135  
Phone 216-433-5718  
Fax  
E-mail jeffrey.haas@grc.nasa.gov

**Gary Halford**

NASA Glenn Research Center  
21000 Brookpark Road  
MS 49-7  
Cleveland, OH 44135  
Phone 216-433-3265  
Fax  
E-mail gary.r.halford@grc.nasa.gov

**James Haliburton**

Norfolk State University  
Norfolk, VA 23504  
Phone 757-823-2993  
Fax 757-823-9054  
E-mail jhollyrock@hotmail.com

**Nancy Hall**

NASA Glenn Research Center  
21000 Brookpark Road  
MS 500-102  
Cleveland, OH 44135  
Phone 216-433-5643  
Fax 216-433-8050  
E-mail nancy.hall@grc.nasa.gov

**Harvey Hall**

Tuskegee University  
Tuskegee, AL 36088  
Phone 334-727-9326  
Fax  
E-mail hhall@engine.com

**Anwarul Haque**

Tuskegee University  
Tuskegee, AL 36088  
Phone 334-727-8039  
Fax 334-727-8801  
E-mail ahaque@tusk.edu

**Rodney Harris**

University of Texas at San Antonio  
6900 North Loop 1604 W.  
San Antonio, TX 78249  
Phone 210-458-5522  
Fax 210-458-5586  
E-mail rharrisj@hotmail.com

**Tracey Harris**

Wilberforce University  
Wilberforce, OH 45384  
Phone 210-458-5522  
Fax  
E-mail richard\_traceyharris@hotmail.com

**Don Henderson**

Fisk University  
1000 17th Ave N.  
Nashville, TN 37208-3051  
Phone 615-329-8622  
Fax 615-329-8634  
E-mail henderns@dubois.fisk.edu

**Edgar Herrera**

University of Texas at San Antonio  
6900 North Loop 1604 W.  
San Antonio, TX 78249  
Phone 210-458-5522  
Fax 210-458-5586  
E-mail echerr@evl.net

**Maria Hill**

Ohio Aerospace Institute  
22800 Cedar Point Road  
Cleveland, OH 44142  
Phone 440-962-3230  
Fax  
E-mail mariahill@oai.org

**Sandy Hippensteele**  
NASA Glenn Research Center  
21000 Brookpark Road  
MS 3-9  
Cleveland, OH 44135  
Phone 216-433-2935  
Fax 216-433-2046  
E-mail sandy.hippensteele@grc.nasa.gov

**Dennis Huff**  
NASA Glenn Research Center  
21000 Brookpark Road  
MS 54-3  
Cleveland, OH 44135  
Phone 216-433-3913  
Fax 216-433-3918  
E-mail dennis.l.huff@grc.nasa.gov

**Myat Khet**  
Hampton University  
Hampton, VA 23668  
  
Phone 757-727-5712  
Fax 757-727-5955  
E-mail myatmyat@hamptonu.edu

**Walter Kim**  
NASA Glenn Research Center  
21000 Brookpark Road  
MS 3-7  
Cleveland, OH 44135  
Phone 216-433-3742  
Fax  
E-mail walter.kim@grc.nasa.gov

**James Kiraly**  
NASA Glenn Research Center  
21000 Brookpark Road  
MS 49-6  
Cleveland, OH 44135  
Phone 216-433-6023  
Fax  
E-mail louis.kiraly@grc.nasa.gov

**Steve Kozak**  
LCO College  
Hayward, WI 54843  
  
Phone  
Fax  
E-mail skozak@lco-college.edu

**Thet Kyaw**  
Hampton University  
Hampton, VA 23668  
  
Phone 757-727-5923  
Fax 757-727-5955  
E-mail thetkyaw@hotmail.com

**David Larkin**  
NASA Glenn Research Center  
21000 Brookpark Road  
MS 77-1  
Cleveland, OH 44135  
Phone 216-433-8718  
Fax  
E-mail david.larkin@grc.nasa.gov

**Marisabel Lebron**  
NASA Glenn Research Center  
Clark Atlanta University  
21000 Brookpark Road  
MS 49-3  
Cleveland, OH 44135  
Phone 404-880-6886  
Fax  
E-mail marisabel.lebron@grc.nasa.gov

**Benjamin Liaw**  
City College of New York  
Mechanical Engineering Department  
Convent and 140th Street  
New York, NY 10031  
Phone 212-650-8020  
Fax 212-650-8090  
E-mail liaw@ccny.cuny.edu

**Mary Jo Long-Davis**  
NASA Glenn Research Center  
21000 Brookpark Road  
MS 60-2  
Cleveland, OH 44135  
Phone 216-433-8708  
Fax  
E-mail mary.j.long-davis@grc.nasa.gov

**Gregory Lush**  
University of Texas at El Paso  
500 West University Avenue  
El Paso, TX 79968-0587  
  
Phone 915-747-6632  
Fax  
E-mail lush@ece.utep.edu

**John Lytle**  
NASA Glenn Research Center  
21000 Brookpark Road  
MS 142-5  
Cleveland, OH 44135  
Phone 216-433-3213  
Fax 216-433-5188  
E-mail jlytle@grc.nasa.gov

**Courtney Malbrue**  
Clark Atlanta University  
223 James P. Brawley Drive, SW.  
Atlanta, GA 30314  
  
Phone 404-880-6619  
Fax  
E-mail cocomalbrue@hotmail.com

**Charles Maldarelli**  
City College of New York  
Convent Avenue and 140th Street  
New York, NY 10031  
  
Phone 212-650-8160  
Fax 212-650-6835  
E-mail charles@chemail.engr.ccnyc.cuny.edu

**Katherine Martin**  
NASA Glenn Research Center  
21000 Brookpark Road  
MS 3-13  
Cleveland, OH 44135  
Phone 216-433-2406  
Fax  
E-mail katherine.martin@grc.nasa.gov

**Carolyn Mercer**  
NASA Glenn Research Center  
21000 Brookpark Road  
MS 77-1  
Cleveland, OH 44135  
Phone 216-433-3411  
Fax  
E-mail carolyn.mercer@grc.nasa.gov

**Eric Mintz**  
Clark Atlanta University  
223 James P. Brawley Drive, SW.  
Atlanta, GA 30314  
  
Phone 404-880-6886  
Fax  
E-mail emintz@cau.com

**Jeffrey Moder**

NASA Glenn Research Center  
21000 Brookpark Road  
MS 5-10  
Cleveland, OH 44135

Phone 216-433-8254

Fax

E-mail jeffrey.moder@grc.nasa.gov

**Claudiu Muntele**

Alabama A&M University  
P.O. Box 1268  
Normal, AL 35762

Phone 256-851-5872

Fax 256-851-5868

E-mail claudiu@cim.aamu.edu

**Iulia Muntele**

Alabama A&M University  
P.O. Box 1268  
Normal, AL 35762

Phone 256-851-5872

Fax 256-851-5868

E-mail iulia@cim.aamu.edu

**Peter Murray**

NASA Glenn Research Center  
21000 Brookpark Road  
MS 50-1  
Cleveland, OH 44135

Phone 216-433-3011

Fax

E-mail peter.j.murray@grc.nasa.gov

**Gorgui Ndeo**

Central State University  
1400 Brush Row Road  
Wilberforce, OH 45384

Phone 937-376-6312

Fax 937-376-6598

E-mail gnado@csu.ces.edu

**Hung Nguyen**

NASA Glenn Research Center  
21000 Brookpark Road  
MS 54-2  
Cleveland, OH 44135

Phone 216-433-6590

Fax

E-mail hung.nguyen@grc.nasa.gov

**Fedja Orucevic**

Alabama A&M University  
P.O. Box 1268  
Normal, AL 35762

Phone 256-851-5872

Fax 256-851-5868

E-mail fedja@cim.aamu.edu

**Shantaram Pai**

NASA Glenn Research Center  
21000 Brookpark Road  
MS 49-8  
Cleveland, OH 44135

Phone 216-433-3255

Fax 216-977-7051

E-mail shantaram.s.pai@grc.nasa.gov

**Eric Pencil**

NASA Glenn Research Center  
21000 Brookpark Road  
MS 301-3  
Cleveland, OH 44135

Phone 216-977-7463

Fax 216-433-8311

E-mail eric.pencil@grc.nasa.gov

**Robert Plencner**

NASA Glenn Research Center  
21000 Brookpark Road  
MS 60-2  
Cleveland, OH 44135

Phone 216-433-7010

Fax

E-mail robert.m.plencner@grc.nasa.gov

**Louis Povinelli**

NASA Glenn Research Center  
21000 Brookpark Road  
MS 5-3  
Cleveland, OH 44135

Phone 216-433-5818

Fax 216-433-3000

E-mail louis.povinelli@grc.nasa.gov

**Carramah Quiett**

Hampton University  
4719 Gloucester Road  
Alexandria, VA 22302

Phone 703-354-1124

Fax

E-mail carraq@aol.com

**Ryne Raffaele**

NASA Glenn Research Center/RIT  
21000 Brookpark Road  
MS 302-3  
Cleveland, OH 44135

Phone 216-433-2057

Fax

E-mail ryne.raffaele@grc.nasa.gov

**D.R. Reddy**

NASA Glenn Research Center  
21000 Brookpark Road  
MS 301-3  
Cleveland, OH 44135

Phone 216-433-8133

Fax 216-433-2306

E-mail dreddy@grc.nasa.gov

**Andrea Reznik**

NASA Glenn Research Center  
21000 Brookpark Road  
Cleveland, OH 44135

Phone

Fax

E-mail andrea.reznik@grc.nasa.gov

**Terri Rodgers**

NASA Glenn Research Center  
University of Toledo  
21000 Brookpark Road  
MS 77-7  
Cleveland, OH 44135

Phone 216-433-8740

Fax

E-mail terri.rodgers@grc.nasa.gov

**Douglas Rohn**

NASA Glenn Research Center  
21000 Brookpark Road  
MS 60-2  
Cleveland, OH 44135

Phone 216-433-3325

Fax

E-mail douglas.a.rohn@grc.nasa.gov

**Robert Romero**

NASA Glenn Research Center  
21000 Brookpark Road  
MS 500-311  
Cleveland, OH 44135

Phone 216-433-5538

Fax

E-mail Robert.Romero@grc.nasa.gov

**Sergey Sarkisov**

Alabama A&M University  
4900 Meridian Street  
Normal, AL 35762-1268

Phone 256-858-8106  
Fax 256-851-5622  
E-mail sergei@caos.aamu.edu

**Loretta Shaw**

NASA Glenn Research Center  
21000 Brookpark Road  
MS 5-10  
Cleveland, OH 44135

Phone 216-433-3931  
Fax  
E-mail loretta.m.shaw@grc.nasa.gov

**Carl Silski**

NASA Glenn Research Center  
21000 Brookpark Road  
MS 500-305  
Cleveland, OH 44135

Phone 216-433-2786  
Fax  
E-mail carl.l.silski@grc.nasa.gov

**Adesh Singhal**

NASA Glenn Research Center  
21000 Brookpark Road  
MS 54-6  
Cleveland, OH 44135

Phone 216-433-3519  
Fax 216-433-6371  
E-mail a.singhal@grc.nasa.gov

**Daniel Sokolowski**

NASA Glenn Research Center  
21000 Brookpark Road  
MS 60-5  
Cleveland, OH 44135

Phone 216-433-3216  
Fax  
E-mail  
daniel.e.sokolowski@grc.nasa.gov

**Sam Sun**

Norfolk State University  
Chemistry Department  
Norfolk, VA 23804

Phone 757-823-2993  
Fax  
E-mail ssun@nsu.edu

**John Taylor**

NASA Glenn Research Center  
21000 Brookpark Road  
MS 86-5  
Cleveland, OH 44135

Phone 216-433-5324  
Fax  
E-mail john.d.taylor@grc.nasa.gov

**Carol Tolbert**

NASA Glenn Research Center  
21000 Brookpark Road  
MS 301-2  
Cleveland, OH 44135

Phone 216-433-6167  
Fax  
E-mail ctolbert@grc.nasa.gov

**Joseph Torri**

NASA Glenn Research Center  
21000 Brookpark Road  
MS 21-13  
Cleveland, OH 44135

Phone 216-433-5454  
Fax 216-433-3124  
E-mail joseph.f.torri@grc.nasa.gov

**Paivi Tripp**

NASA Glenn Research Center  
21000 Brookpark Road  
MS 500-313  
Cleveland, OH 44135

Phone 216-433-2812  
Fax  
E-mail paivi.tripp@grc.nasa.gov

**Long Truong**

NASA Glenn Research Center  
21000 Brookpark Road  
MS 301-2  
Cleveland, OH 44135

Phone 216-433-6153  
Fax  
E-mail long.v.truong@grc.nasa.gov

**Carol J. Vance**

NASA Glenn Research Center  
21000 Brookpark Road  
MS 86-8  
Cleveland, OH 44135

Phone 216-433-5273  
Fax  
E-mail carol.j.vance@grc.nasa.gov

**Jose Vega**

NASA Glenn Research Center  
21000 Brookpark Road  
MS 3-1  
Cleveland, OH 44135

Phone 216-433-5453  
Fax  
E-mail jose.m.vega@grc.nasa.gov

**Tiffany Ware**

Tuskegee University  
Tuskegee, AL 36088

Phone 334-727-8039  
Fax 334-727-8801  
E-mail tiffany\_ware@hotmail.com

**Bill Wessel**

NASA Glenn Research Center  
21000 Brookpark Road  
MS 3-6  
Cleveland, OH 44135

Phone 216-433-2350  
Fax  
E-mail vernon.w.wessel@grc.nasa.gov

**Barbara Wiedenmannott**

NASA Glenn Research Center  
21000 Brookpark Road  
MS 86-1  
Cleveland, OH 44135

Phone 216-433-8707  
Fax 216-433-5100  
E-mail b.wiedenmannott@grc.nasa.gov

**Fred Williams**

Central State University  
Dayton Hydroelectric  
1400 Brush Row Road  
Wilberforce, OH 45384

Phone 937-275-6113  
Fax  
E-mail williams25@prodigy.net

**Henry Wroblewski**

NASA Glenn Research Center  
21000 Brookpark Road  
MS 142-3  
Cleveland, OH 44135

Phone 216-433-2095  
Fax  
E-mail henry.j.wroblewski@grc.nasa.gov



